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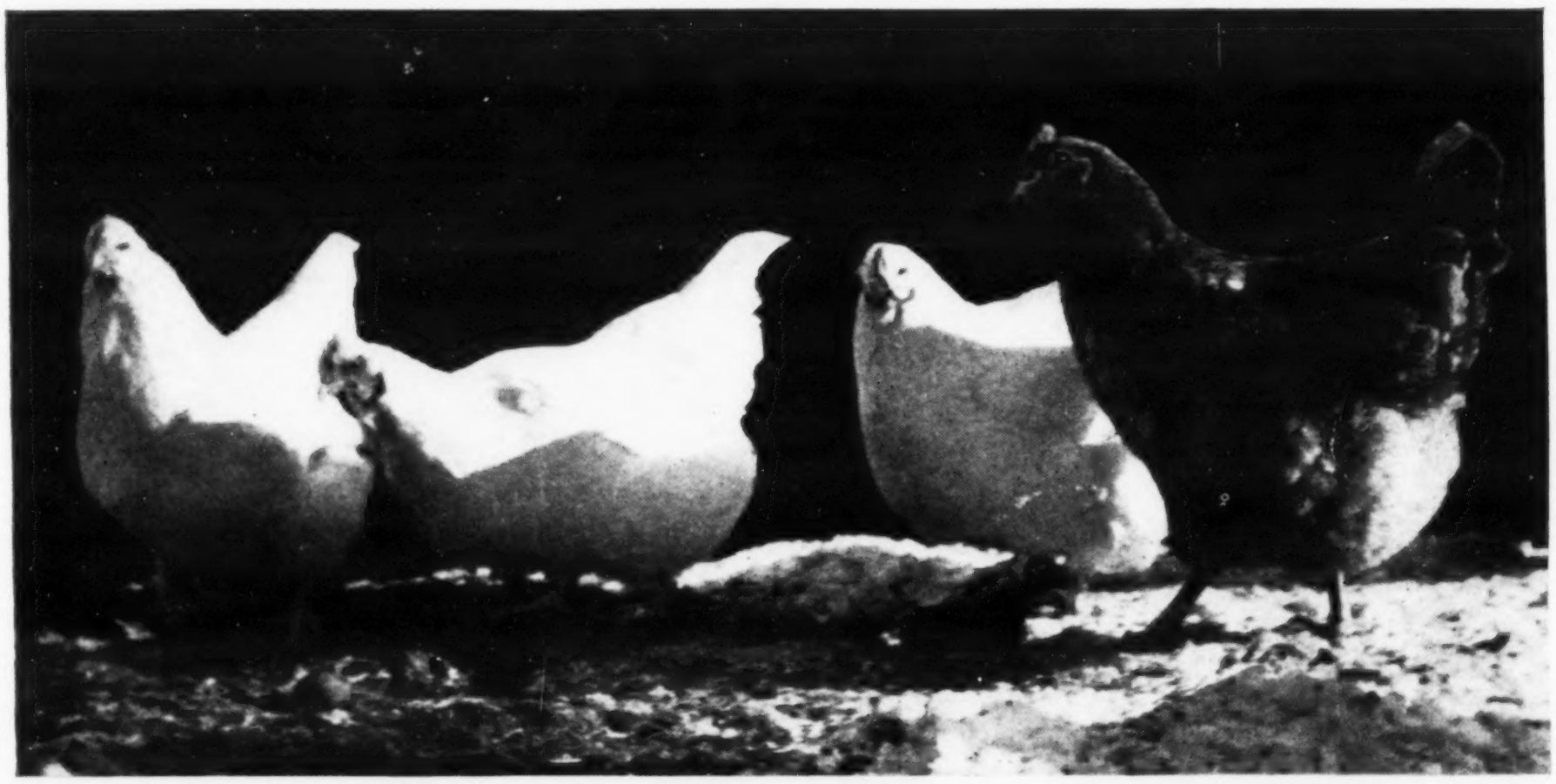

REPTILIAN FOWLS

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Shamel, Pomeroy and Caryl

A Peloric Violet
L. R. Detjen

OCTOBER, 1925 VOL. 16 No. 10

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The

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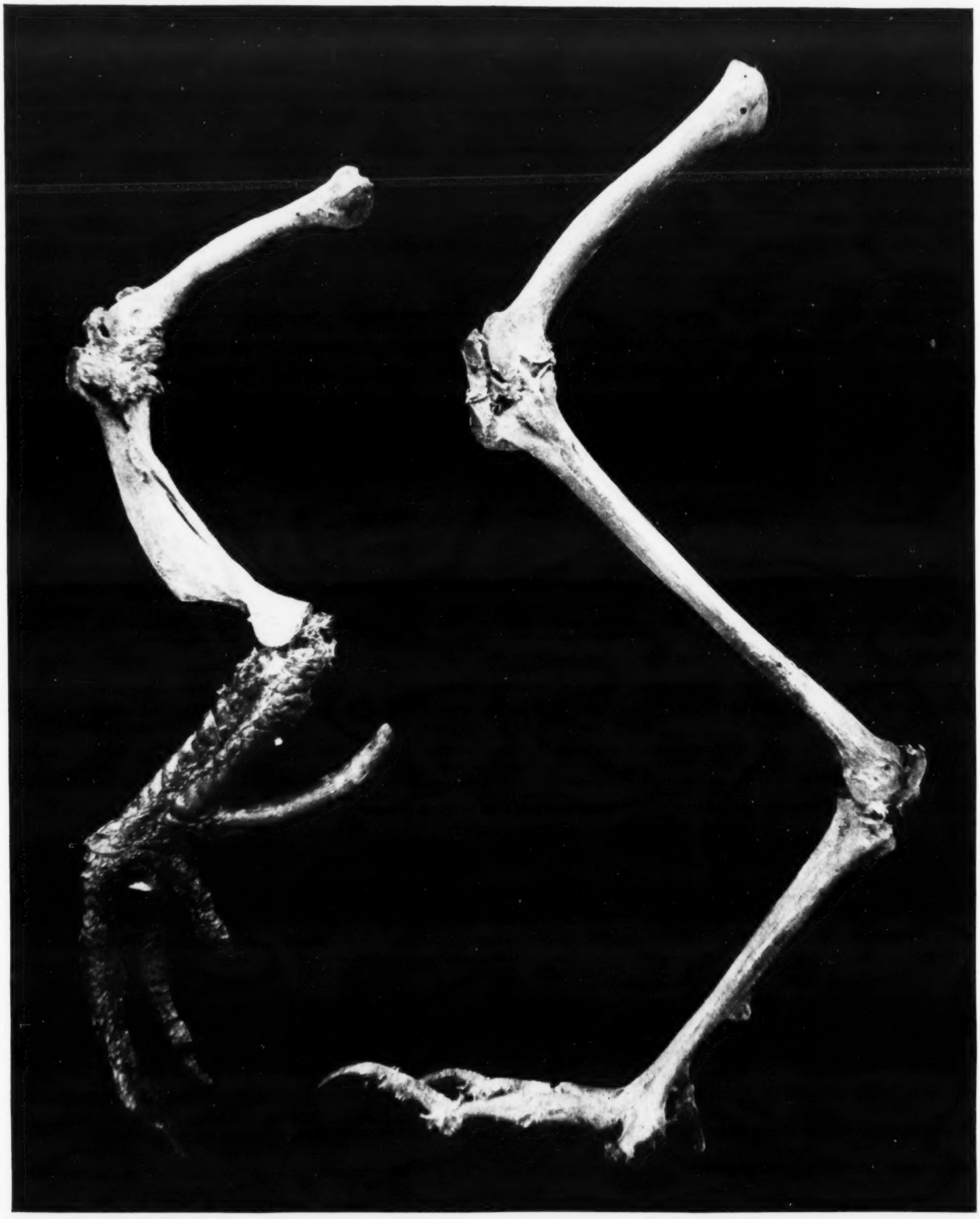


LEG BONES OF REPTILIAN FOWL AND OF NORMAL

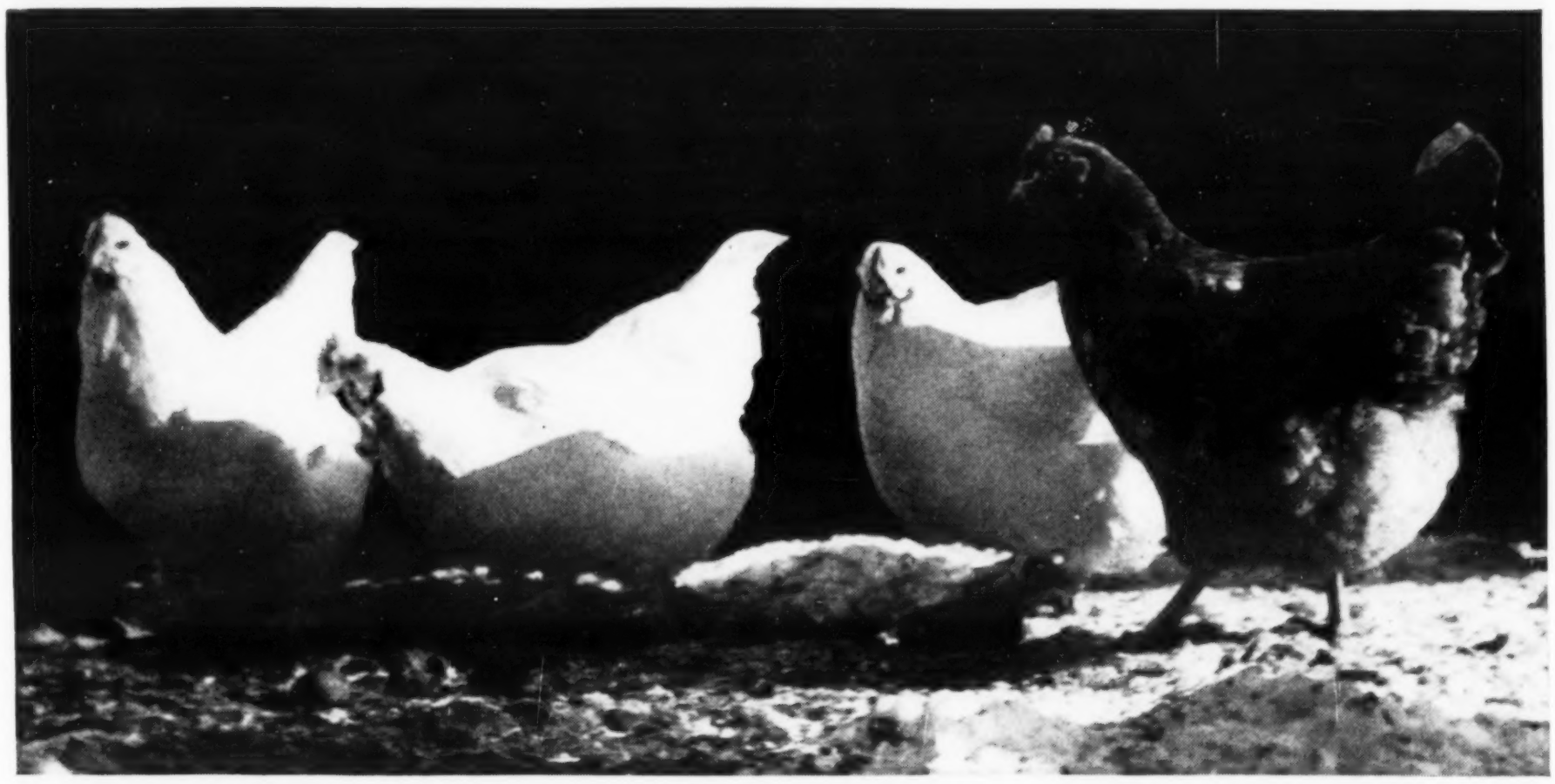
Frontispiece

All leg-bones of the creepers are abnormally short, but the "crus" or drumstick is the most severely affected. In the normal fowl the body is supported at this point by but a single bone, the tibia, the fibula being represented by a small splint at the upper end. In the "creepers" the fibula is complete and the tibia is much shortened and curved. In all birds only the tibia is normally developed, and this character appears to be a reversion to a reptilian type, for reptiles have both of these bones.

REPTILIAN FOWLS

A Study in Atavistic Heredity

IRA EUGENE CUTLER
Department of Zoology, University of Denver



"CREEPERS" AND A NORMAL HEN
Figure 1

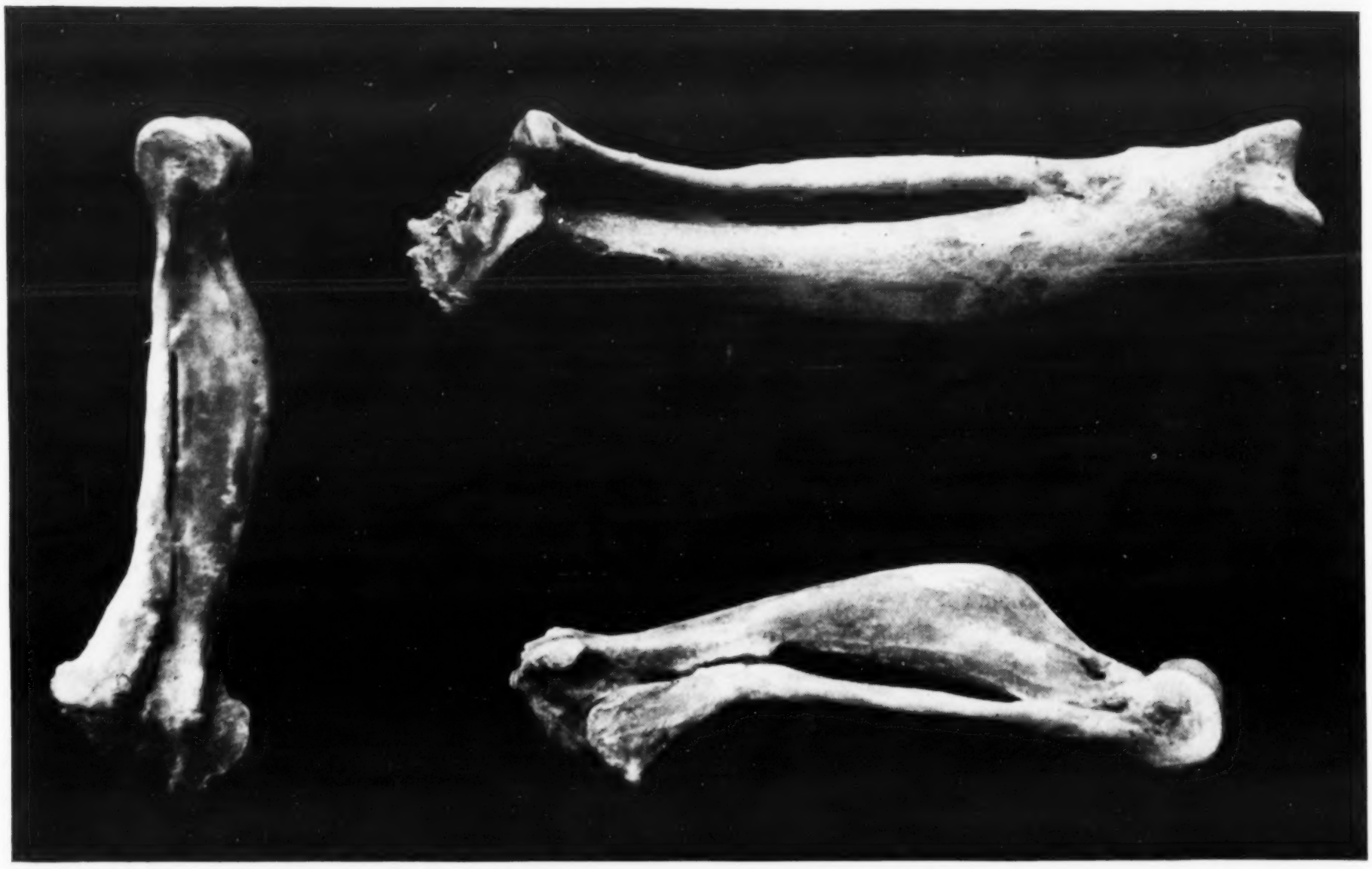
"Creepers" or "brevicrews" are an odd variety of fowls that have been known for centuries. Their legs and wings are abnormally short but they are normal in other respects. The three shown here are not squatting down,—one of them is even taking a step. They are as far off the ground as their short legs will let them get.

PAPERS and theses upon heredity and evolutionary topics are practically numberless, but the more phases that are dealt with, the more types of animals studied, whether fortuitous or retrogressive, the better will be our understanding of this universally interesting subject.

For some twenty-five years the author has been breeding and making a study of a peculiar strain of the ubiquitous animal known as the hen, which has, science tells us, descended from the wild type of birds known as *Gallus gallus* or *Gallus bankiva.*

The variety in question has been known for centuries, along with other odd varieties such as Frizzles, Rumpless, Silkies, but no special study seems to have been made of it. These fowls are called Dumpfries or Creepers in the Old World, and in America Creepers or Brevicrews, because of the unusually short legs. They have the appearance of sitting even though they are standing.

These birds seem not to be popular in the old country, and in America they are bred only by a few who wish something different as well as valuable. As a boy the author became interested in them, and, after coming West, had a few sent him, more for old association's sake than for anything else. At one time he had as many as six or seven varieties of these short-legged fowls—barred, blue, black, buff, white, frizzles, etc., but for lack of



"CREEPER'S" DRUMSTICKS

Figure 2

There is a considerable variation in the development of the fibula, which is fused to the tibia at both ends. Apparently the fibula grows more slowly than the tibia, causing the latter to be so extremely thickened and bent.

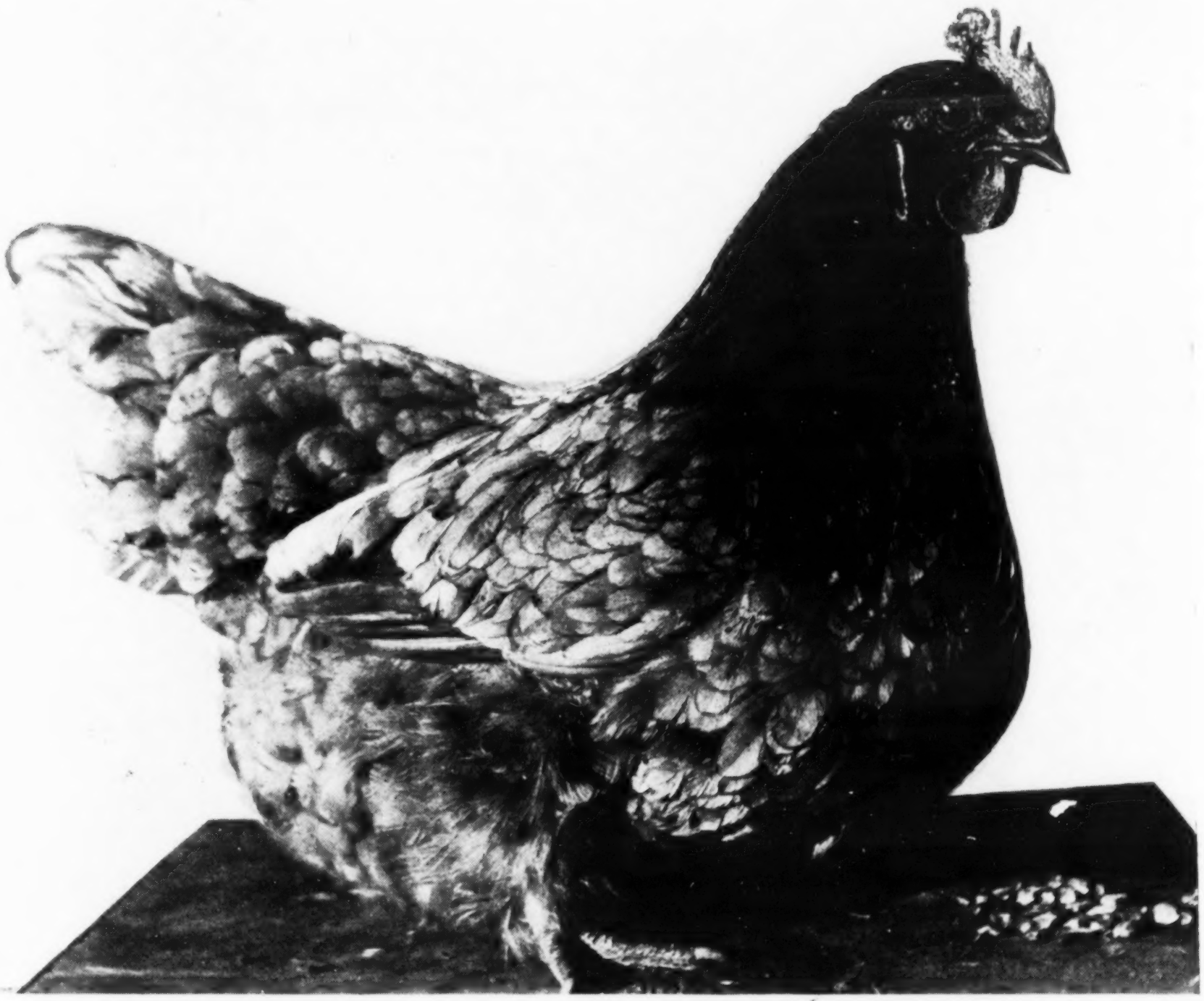
room and also because of the poorer dressing qualities of all colored strains, none but the white were retained for study.

Leg and Wing Bones Shortened

The peculiar characteristics which are the direct subject of this paper seem never to have received careful study. The great diversity of these birds from all other known forms lies in the appendages, wings and legs, both of which are very much shortened. In other respects their structure is similar to other breeds of fowls. The wings show no other change than the shortening of all the individual bones. In the legs all bones are correspondingly shortened, but in the crus or "drumstick" we find two complete bones extending the whole length, tibia and fibula, both being fully developed. In this they differ from all known breeds of fowls and from all other birds as well. Both in the modern birds and in fossil forms the tibia is the main support for this part of the leg, with only a small splint to represent the fibula.

A study of the fossil birds seems to indicate that they generally had a strong tibia, with only a splint to represent the fibula. The Archaeopteryx shows no fibula at all, but the Hesperonis and Ichtheornis both show the splint-like fibula, which corresponds to the same structure in our modern birds.

In the development of these two bones in the creeper fowls, the fibula ankyloses firmly to the tibia distally and slightly anteriorally, about three quarters of an inch from the joint. There seems to be also an unequal lengthening, the fibula developing more slowly, causing the tibia to be much bent forward and thickened near the hock. There is very great variation of this character. Some of the chicks



A CREEPER HEN

Figure 3

Contrary to appearances she is standing. The "creeper" character of short legs and wings can be transferred at will to fowls of any color or build. Their short legs make the hens particularly useful as mothers. They rarely step on chicks for they normally move the feet without lifting them far from the ground.

when hatched show a peculiar outbending of the leg at the knee and hock on one side. Such specimens move about in a manner similar to a chick with a broken leg. In a few instances individual specimens show this abnormality on both sides, and they are absolutely unable to walk at all, as the body cannot be lifted from the ground. When attempting to follow the mother their movements give one the impression of a small lizard, as they use both wings and legs. Here we have a lacertilian rather than a dinosaurian characteristic. The two full bones are more or less dinosaurian, but the turning of the legs to the side is surely a reversion to a lower type, like that of the lizards. These abnormalities are evidently strongly atavistic in character.

It is commonly held that birds developed from the bipedal dinosaurs or that they both sprang from a common ancestry. The facts brought out in this paper may help to throw some light upon this perennially interesting problem.

Breeding Results

I had been breeding these birds for a number of years before I chanced to discover the main peculiarity. Before that time I kept no careful records, so in working out the problem

I have had to rely largely on my memory. My stock has never been large, and until recently I have not attempted to breed the fowls *inter se* on a sufficient scale to develop a homozygous strain.

When these peculiar fowls are bred to normal birds about half the offspring are creepers, the other half normal. Mating the creepers *inter se* increases their proportion in the progeny, and in addition some of the chicks often have the extreme abnormality mentioned above. These are always some with the abnormality on one side. The foregoing suggests that the "normal" creepers are all heterozygous, and that the extreme abnormality represents the homozygous form. Since it has not been possible to raise any of these chicks, this hypothesis has not been tested genetically. Should this prove to be the case, we may class this character with a number of others, many of them skeletal abnormalities, which are lethal or semi-lethal in the homozygous condition. Dunn recently suggested in this Journal that rumplessness acted in this way, though in that case no viable homozygous rumpless chicks seem to have been produced.

As a breed of poultry the Brevicrews are just as fine as any other, being about the size of the Plymouth Rock. By careful crossing, they may be had in any of the standard breeds, of any color and type of feathering. They are good egg producers, poor runners, poor scratchers, poor fliers, fair foragers if given the chance, and they can be kept in pens with low fences. They are fine sitters and the very best of mothers, because when they walk they almost never crush a chick. When the foot is put forward in their shuffling gait it is lifted but little, pushing the chicks out of the way. Whether she desires to or not, the mother always is in condition to shelter any chick that may need protection and warmth, as the feathers reach the ground. They also proved to be excellent mothers in my work of rearing pheasants.

The Fruits of America

AMERICAN FRUITS, by Samuel Fraser. Pp. xv + 888, price $8.00. Orange Judd Publishing Co., Inc., New York And London, 1924.

A fruit growers manual remarkable for its literary style and the subject matter covered. It is a most readible volume covering the culture of both temperate and tropical fruits of Canada and the United States. Such a discussion of both temperate and tropical fruits in one volume will appeal to the increasing number who have fruit interests in the north in summer and in the south in winter.

The discussion of cultural practices and principles is reasonably up to date. No other single volume is available to fruit growers which gives so much essential practical information. Perhaps its chief weakness is that it tries to cover too much. Thus the discussion of diseases and insects is too meager to furnish the grower all the information needed and to include this it has apparently been necessary to omit much in regard to individual fruits that would seem of greater value.

It is to be hoped that the author will correct several mistakes in a new edition. For example, several blackberry varieties not to be obtained at present or of little importance are mentioned (p. 506), while no discussion of the Evergreen, one of the most important blackberry varieties, is given. In the variety descriptions (p. 821) the Evergreen is listed but listed again as the Atlantic dewberry.

G. M. D.

NEMIC SPERMATOGENESIS

N. A. Cobb
U. S. Department of Agriculture

EFFORTS to homologize nemic sperms with those having vibratile appendages have not been very happy. The following observations may serve to suggest that the modes of nemic spermatogenesis add to the probability that nemas constitute a very ancient phylum whose relationships are most likely to be disclosed by a study of its more representative (non-parasitic) forms.

Definitions. Spermatidium; one of a plurality of cells derived from a spermatid by subdivision; a secondary, tertiary, or quaternary, etc., spermatid. *Spermule;* an individual spermatidium which, after growth and transformation, is capable of activating or fertilizing an egg,—being *not* a metamorphosed spermatid, but a descendent of a spermatid, one or more cell-generations removed.

Spermatogenesis. At the blind end of the single testis of the nema *Spirina parasitifera* (Bastian '65) Filipjev,—a free living marine species, common an inch or two deep in sand and among small stones between the tide marks of protected coasts on both sides of the North Atlantic through a wide range of latitude,—the primordial gonic elements give rise by 14-chromosome mitotic division to numerous twin cells, which arrange themselves tandem in the testis, where each cell, growing, forms a primary spermatocyte. At the end of the growth period the primary spermatocytes, one after another, divide transversely, i.e., at right angles to the nema's body axis, and then, sometimes almost simultaneously, longitudinally, to produce four similar, juxtaposed spermatids, each soon packed with several thousand very slightly elongate microsomes, nearly all of which are located outside the large central, faintly alveolated nuclear space.

In the first of these two divisions the chromosome number is reduced to seven. Probably the smallest one of the seven chromosomes of the secondary spermatocytes differs slightly in relative size in the two cells. Thus far the spermatogenesis presents nothing very new or striking, but the amount of growth,—from 3 to 60 microns,—is worthy of note, and connected with reduction there is a more or less orderly (e.g. more or less definitely orientated) extrusion from the cells of structureless looking chromatoid substance,—barely possibly by a very "degenerate" mitosis; these chromatoid masses are soon absorbed.

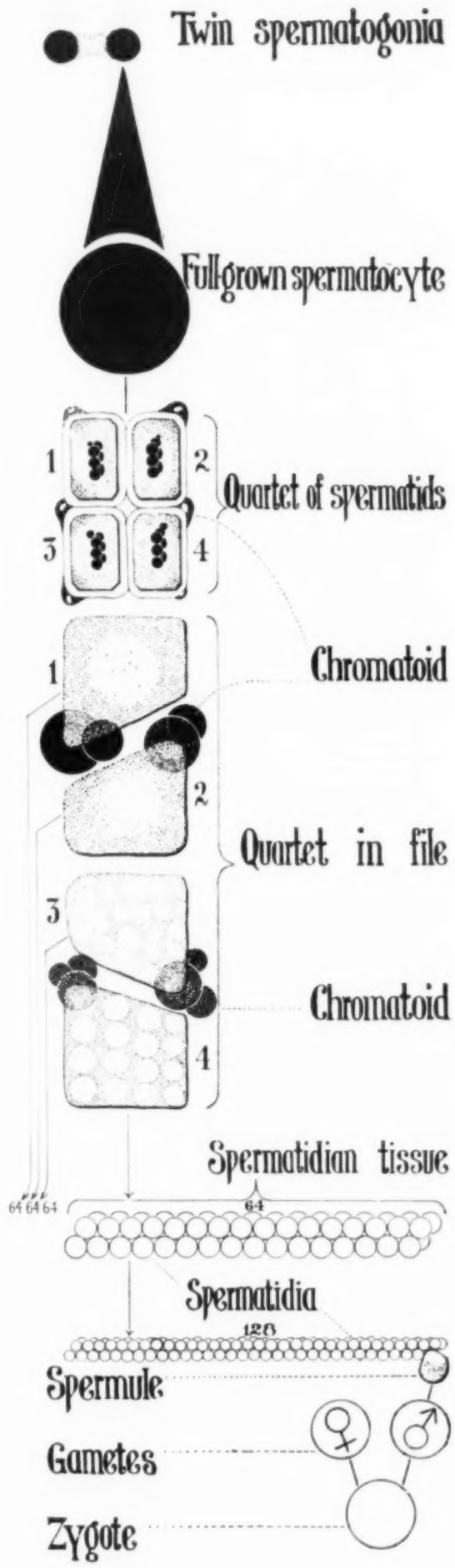
"Normally," the four cells just described would develop into four sperms, but here the spermatogenesis proceeds as follows: Moving along the testis with soldier-like precision, the two caudad members of the quartet form a tandem, followed by the other two, also in tandem; i.e., the quartet falls into single file. These spermatids in file grow, and one after another divide internally without evidence of mitosis into 64 uninucleate elements which proceed to surround themselves with walls and *form a tissue of* 64 *cells.* As this tissue leaves the testis and enters the duct it elongates (2-3 nuclei abreast), and each of its 64 cells in turn, following on the disappearance of the microsomes, acquires four equal, refractive, spherical granules (4 microns in diameter), and the tissues thus take on a granulated appearance,—the nuclei and cell-walls being almost completely hidden by the closely packed granules. By the time the cephalad part of each tissue enters the duct the caudad part has un-

dergone a further change, in that the four granules, *each dividing endogenously into four similar* but smaller spherical granules, endow each cell with 16 granules.

This very interesting behavior of the granules more than suggests a different order of mechanism from that typical of cell division, but since irritability, ingestion, transportation, transformation and so forth all seem involved, it appears necessary to base the concept on what is known of cell physiology and mechanics; the changes, however, are carried out on a smaller scale and doubtless with a more limited variety of molecules forming a different kind of plasm. In short, the facts indicate a distinctly lower order of "organism." Many of what now are often called *lower* organisms might better be regarded simply as *less complicated*. Thus certain ciliates are smaller and less complicated, rather than "lower," as compared with nemas for instance.

As the tissue proceeds along the duct the cells containing 16 granules undergo a further diminution in the size of their granules, and a change in the number and nature of the granules, so that the cells become more transparent; at the same time the nuclei *divide mitotically*, (7 chromosomes), *giving rise to a tissue of 128 cells*. The evidence that this increase is by mitosis is as follows: 1. At the part of the duct where this change is taking place, the sizes, form and position (in pairs) of the new nuclei are what would be expected from mitotic division. 2. The new smaller nuclei,—posterior to the larger, as yet undivided, nuclei,—stain more strongly. 3. Occasionally 7-element spindles can be seen. 4. No trace has been seen of any other sort of division.

Two or more such tissues as that described fill the duct of the male nema; the number of tissues varying with the age of the nema and with the copulatory history. The tissues seem to be of two styles,—and, if so, perhaps correspond to the two styles of chromosomes in the secondary spermatocytes.



SPERMATOGENESIS IN NEMATODES

Figure 4

Spermatids are formed in the "conventional" way,—four from a spermatocyte. Instead of metamorphosing into tailed spermotozoa, the spermatids undergo further changes and divisions, which give rise to a spermatidian tissue of 64 cells from each spermatid. These by mitotic division produce 128-celled tissues. One by one these 128 spermatidia grow into spermules, each of which is capable of activating an egg and initiating normal development.

Fertilization and Syngamy. The two sexes of *S. parasitifera* are about equally common. During copulation the male passes the spermatidian tissues on intact to the female, and afterward they may be seen in the uteri, often jumbled, sometimes extended along the length of the two uteri.

Fertilization is preceded by increase in size of that cell of the spermatidian tissue adjacent to the ovum next to be fertilized and its change into a cell, spermule, having the form, and discharging the functions, of a nemic sperm as hitherto understood,—a transformation involving also a growth of about 50 per cent in diameter—together with a greater growth longitudinally, and a marked change in the granulation of the cytoplasm. These cells, detached one by one, fertilize the eggs in what seems a normal manner. The polocytes seem normal. The female gamete has seven chromosomes.

This method of spermatogenesis is normal to nemas. A large number of species belonging to numerous and varied genera are known to the writer in which the general appearances in the gonad of the male so closely resemble those of *Spirina parasitifera* as to leave him no doubt that the details of their spermatogenesis will show the features here described, or something similar. The formation of a spermatidian *tissue* is not an essential feature; in others of the above species the spermatidia may remain separate.

Current postulates must be modified in order to account for hereditary transmission in this and similar animal species. The factors usually believed to reside wholly, or in part, in the chromosomes must here, in order to accord with the usual theories of heredity, be "divisable" in the male into numerous parts such that when they appear in the spermule they are capable of bringing about "normal" syngamy.

It will be interesting to discover how factors or genes, concepts essential to clear thinking on the subject of heredity, can be imagined to "carry on" through the mazes of the division that, extending throughout the spermatid, gives rise without mitosis to 64 apparently equivalent elements in the spermatidian tissue. The spermatidian tissues (aggregates of haploid cells,—gametophores) seem more clearly reminiscent of the alternation of generations in plants than any animal structure hitherto made known.

Subjoined is an alteration of the Boverian diagram, illustrating the spermatogenesis described.

The features accompanying and following the oöcytic synapsis seem at least a gesture toward the path followed in the spermatogenesis, but they have not yet been carefully studied.

It is hoped to continue the investigations.

Two Errors in the Review of Gates' *Heredity and Eugenics*

In the July JOURNAL OF HEREDITY (p. 262) the title of Dr. R. R. Gates' *Heredity and Eugenics* was mistakenly given as *Genetics and Eugenics*. The price of this book is $4.80, not $3.00 as stated in the review.

FRACTURE OF CHROMOSOMES IN RYE

JOHN BELLING
Carnegie Institution of Washington

Figure 5

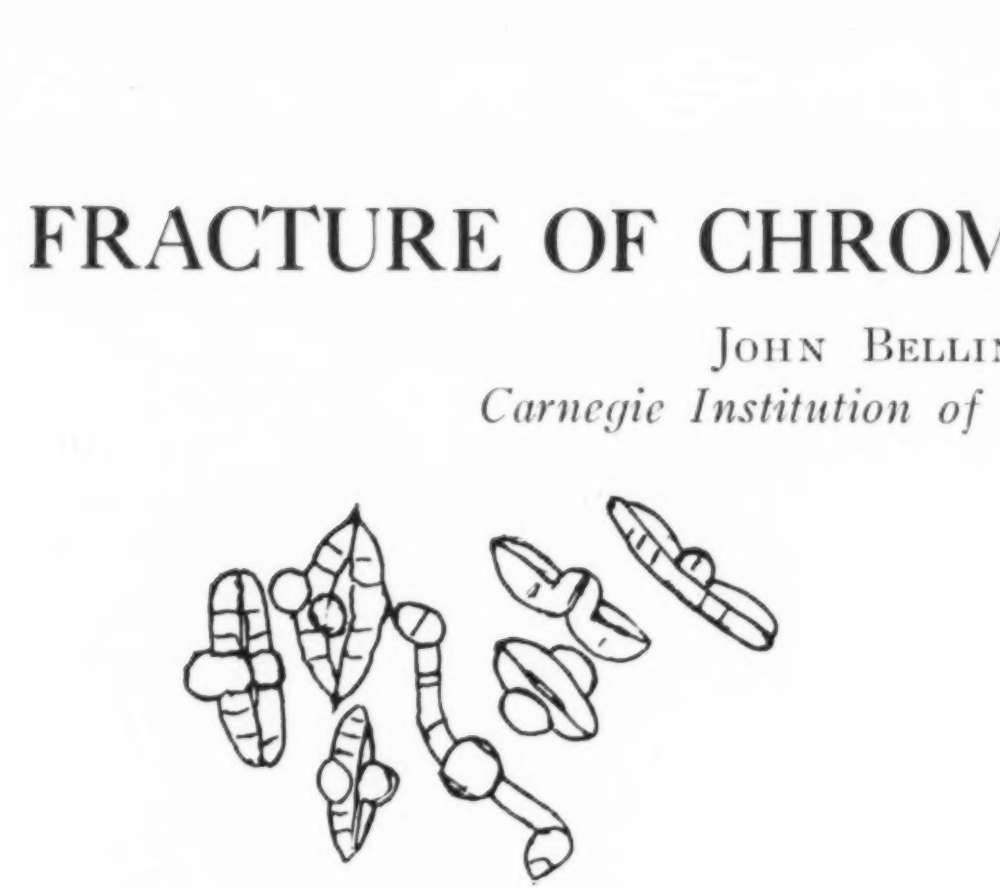


Figure 6

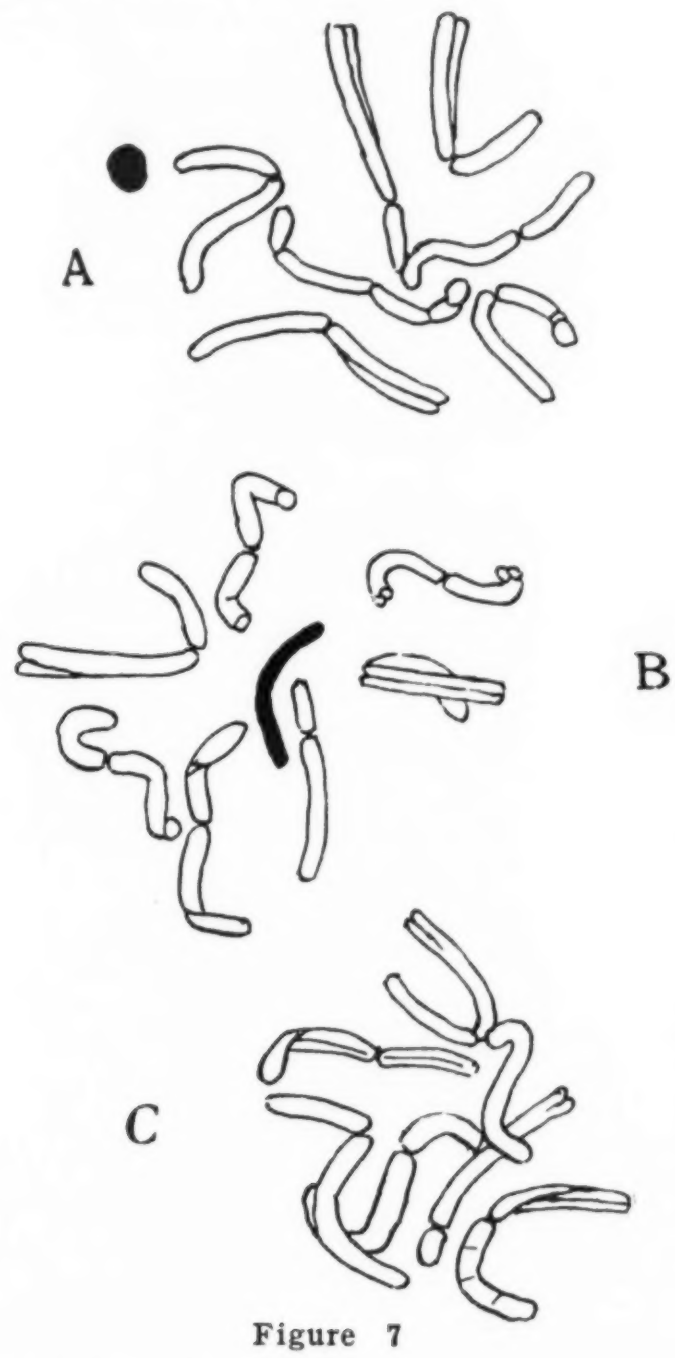


Figure 7

SEVEN AND EIGHT CHROMOSOMES IN RYE

Figures 5-7

Rye usually has seven chromosomes but occasionally eight are found. The extra chromosomes are black in the drawings.

IT has been shown in Japan* that rye has usually seven, but sometimes eight pairs of chromosomes, the extra pair being small. This state of affairs has been apparently brought about by fracture of one of the largest pairs. Plants from a field of rye in Long Island also showed either seven pairs of chromosomes or eight pairs. In one case, all the grains of an ear had germinated together, and those plants examined had eight pairs of chromosomes.

Figure 5 is a camera drawing of the first metaphase in a pollen-mother-cell of the ordinary seven-chromosome rye. Figure 6, A and B, represents two metaphases of the reduction division in a pollen-mother-cell of the eight-chromosome rye. The extra pair is solid black. In Figure 7, A and B, are from pollen-grains of the eight-chromosome rye. The extra chromosome is solid black. C is from a pollen-grain of the ordinary seven-chromosome rye.

It would be interesting to cross these two kinds of rye and find what happens in the hybrid with regard to the small chromosome.

These preparations were made in iron-acetocarmine, and drawn with the camera.

*GOTOH, KAZUO. 1924. *Bot. Mag. Tokyo,* Vol. 30, p .135.

BIRTHRATES IN THE FAMILIES OF MICHIGAN STATE COLLEGE GRADUATES*

C. V. Green and H. R. Hunt
Department of Zoology and Geology, Michigan State College

THE present investigation was undertaken in order to ascertain whether the prevalent inclination of the better educated portions of the population to limit the family size has affected the birth rate among the graduates of the Michigan State College. Such studies aid in determining the contemporary direction of human evolution. If the birth rates in well-endowed human strains decline too much there will be a relative decrease of persons of superior qualities. Such a decrease means racial deterioration.

Michigan State College was founded in 1857 near Lansing. In its early days instruction was offered only in scientific and practical agriculture, but gradually, beginning in 1885, other courses, including engineering, home economics, veterinary medicine, forestry, applied science, and a literary course were added. The present enrollment is approximately 1,800 students (men and women), but until a few years ago it was much smaller. The institution is a good example of the smaller state college of the middle west.

The progress of civilization is dependent upon an adequate number of able and cooperative individuals. However, opinion varies as to the best methods of maintaining this number. Some profess to believe that the human mind is a blank at birth and that environmental influences are wholly responsible for character and ability. But geneticists are now agreed that intelligence is, in part at least, determined by heredity.

Inheritance of Mental Ability

It is known that physical variation is of universal occurrence among plants and animals, including man, and that many of these variations are inherited. In man, for example, longevity, hair and eye color, Huntington's chorea, hæmophilia, defects in dentition, etc., are known to be inherited. The existence of mental variation in man is also universally recognized. The work of Galton[1], Woods[2], Davenport[3], Goddard[4], Thorndike[5], Pearson[6], and other investigators has proved that mental traits and abilities are inherited.

It is evident that racial vigor depends upon an adequate rate of reproduction among the physically and mentally well endowed. But investigations conducted both in the United States and Europe have shown that the birth rates among the capable and successful are low. So it is not surprising that studies of the birth rates in the families of college graduates, who are probably a selected group as regards intelligence, have uniformly disclosed a rather low rate. This question has been discussed so frequently in the pages of the Journal of Heredity that no detailed review of the literature will be given.†

Several difficulties were encountered in the collection of data. In the first place, the records of the M. S. C. alumni office are rather incomplete relative to marriages and still more meager as to births. Therefore, in order to get the requisite data, it was necessary to send questionnaires to each of the male graduates yet living, depending wholly upon their cooperation and

*Formerly the Michigan Agricultural College.

†The reader is referred to the papers of Phillips,[7] Nicolson,[8] Banker,[9] Hunt,[10] and Cattell[11] for further information on this point.

good will for satisfactory replies. The Alumni Register of 1916 supplied the names and addresses of the living and indicated the deceased.

In a study of this sort the results would be of little value if the families were not complete. Therefore only those who graduated not later than 1899 are included, as it was assumed that the wives of these had usually attained, or passed, the age of forty-five, the general limit of child bearing. This assumption was borne out remarkably well by the data collected. The proportion of deceased members was so large and the numbers so small, in the classes before 1870, that it was inadvisable to study classes of an earlier date. As the number of women graduates between 1870 and 1899 was very small, the study was confined to the men.

Method of Obtaining Data

A questionnaire was sent out in November, 1924, to each living male graduate of the classes from 1870 to 1899 whose address could be ascertained. Eighty per cent of those to whom questionnaires were delivered responded. In February, 1925, a second questionnaire was dispatched to everyone whose first reply was incomplete.

The content of the questionnaires is given below. Following an explanatory introduction, these questions were asked:

(1) Are you single, married, divorced or a widower? (Answer by underscoring.)

(2) If married, what was your age at marriage?

(3) If married, how many children have you? (Underscore the number.)

No. living	Females:	0, 1, 2, 3, 4, 5, 6
	Males:	0, 1, 2, 3, 4, 5, 6
No. deceased (excluding stillbirths)	Females:	0, 1, 2, 3, 4, 5, 6
	Males:	0, 1, 2, 3, 4, 5, 6

(4) If married, what is your wife's present age?

Table I gives the total number of male graduates in the classes from 1870 to 1899, the number surviving to date, and the number of questionnaires returned. Table II presents data on marriages which may be perused before beginning an analysis of the birth rates. There is a slight discrepancy (four cases) between Table II (number single plus number married) and the number of questionnaires returned, as shown in Table I. This difference is due to the fact that five deceased alumni, for whom complete and authentic information was obtained, are included in Table II, while one questionnaire was discarded because of obvious errors in it. Thus the total number of individuals listed in Table II exceeds by four the number of questionnaires returned, as indicated in Table I.

It is advisable to consider some of the characteristics of the data before drawing conclusions. (1) Since the number of individuals involved is small, the conclusions reached are of general importance only when considered in conjunction with similar studies among the alumni of other colleges, and among other groups of the population.

(2) In a few cases the wife was less than forty-five years of age. The women who have not yet reached forty-five may bear more children, yet the number of such wives (only thirty-two were younger than forty-five years) in this study is so small that possible additional children cannot greatly alter the conclusions.

(3) Sometimes the questionnaires were not fully filled out, so that it was not certain whether there had been any deceased children in the family. The data on children in such questionnaires were not employed in the computations given below.

(4) The 518 (72.7%) living alumni form a group which has thus far withstood the onslaughts of disease; 195 have died. Bell[12] has shown that long-lived persons have a higher average fecundity than short-lived ones. Therefore, it is probable that the number of children per family and per graduate is higher in the surviving seventy-three per cent of the alumni than in the entire group of graduates, which of course

includes the living and the dead. More than ninety-eight per cent of the married alumni whose offspring are used in the computations still survive. Therefore, those married graduates who returned the questionnaires have probably been more fecund, as have the surviving alumni in general, than the entire body of graduates, living and dead.

As would be expected, there has been a proportionately greater number of deaths among the earlier graduates (39.6 per cent for the period 1870-1884) than among the later (19.3 per cent for the period 1885-1899). The larger average number of children in the earlier period (see Table IV) may be partly explained by the fact that the earlier parental group has undergone a more rigorous selection than the later one. There is no basis, however, for supposing that those who returned the questionnaires differ on the average in physical vigor from those, still living, who did not return them.

(5) Probably those alumni who returned the questionnaires have a greater general interest in children than those who failed to do so. It is likely that an individual who has never cared much about children might often consider such a questionnaire as being of little importance. Such persons would be less likely to have children than those whose interest is greater. Therefore the average number of offspring reported is probably greater than it would have been had all the surviving alumni filled out the blank. Undoubtedly the average fecundity of the parents studied has been higher than the average fecundity for all the graduates from 1870-1899 and for the living group as a whole.

Analysis

With these preliminary explanations in view, we may now proceed to an analysis of the data. One apparent conclusion is that a disproportionately small part of the unmarried graduates answered us; less than two per cent of those returning the questionnaires declared themselves single. The percentage of unmarried men is doubtless higher than this in the whole group graduating from 1870-1899. Thus our sample was probably a selected and not a random one. Owing to the paucity of single men reporting, and the consequent lack of reliability of our data as far as the percentage of unmarried individuals is concerned, no conclusions can be drawn as to the possible decrease in the marriage rate.

The decline in the birth rate among the male graduates about whom sufficient data were given by the questionnaires has probably not been of statistical significance. The average number of children per married alumnus and per alumnus is shown in Table III.* Only those families were included in which the total number of children to date was learned. Perhaps a few of the families, especially in the later periods, may be further augmented, since in a small number of cases the wife has not yet reached the age of forty-five years. This table discloses changes from period to period with perhaps a general, but not a progressive, decline in the birth rate.

The data for the graduates are shown in Table IV in two fifteen-year periods in place of six half-decade periods. Table IV again includes only those families in which the total number of children to date (dead as well as living) was ascertained. The difference in family size per married male graduate in the two periods is $.49 \pm .21$ children. A difference of this size or larger, if due purely to chance, will occur about twelve times per hundred. The difference, therefore, probably has no statistical significance, since it may have been due to chance. However, one should remember that the alumni of the period 1870-1884 compose a group more highly selected for vigor

*Probable errors have not been computed for the averages in Table III because, when treating the data by five-year periods, the numbers per period are rather small, and because probable errors have been determined for two fifteen-year periods in Table IV.

(longevity) than the group for 1885-1899. Therefore the higher per capita birth rate in the earlier group may have been due to greater parental vigor, since it is known that long-lived men have more offspring than the short-lived. If the later group had been equally selected for longevity, the difference in family size might not have been so great.

There is a difference between the two periods of .48±.21 in the number of children per male graduate. This difference is likewise probably not significant. It is likely that the data do not constitute a random sample of the living alumni, because the percentage of single men reporting is so low. If this be so, the actual average numbers of children per living graduate are somewhat less than our computations show.

There are two other points upon which the data given in Table IV do not meet all the requirements for a thorough analysis. In cases where the wife is now dead or divorced (of which there are thirty-seven) the graduate may remarry and have more children. Nine wives are forty-four years of age and twenty-three are less than forty-four. It is possible that the families of these may still be augmented, since the mother may yet be capable of bearing children.

Is the Group Maintaining Itself?

More important than the birth rate itself is the question whether the rate has sufficed to replace the parental group. This group (husbands, wives, and single men), totaling 574 individuals, has produced 716 children.* If this parental group is to replace itself, 574 children must attain about twenty-three years of age, the approximate age of graduation of the father. If the death rates among the offspring of the group which returned completely filled out questionnaires were the same as for the general population (see Glover's tables[13] as a basis for computations) the number of children surviving to twenty-three years would be not far from 560. Table V gives our estimates. However, the death rate has probably been much lower among the children of these graduates than in the general American population. (1) Being educated and intelligent parents (at least the fathers are such), they have probably provided an exceptionally good environment for their children. (2) We are dealing with a group from which death has removed many of the weaker, leaving it in all probability with a higher average vigor than is found in a general population. But good health is inherited. Hence the children of these graduates ought to live longer, as a rule, than the children of the population forming the basis of Glover's mortality tables. Therefore we believe we are justified in concluding that the group of graduates who returned our questionnaire fully and satisfactorily filled out has probably produced enough children to replace the group.

This conclusion is supported by the data presented in Table VI. The parental group of each half decade has surviving offspring equal in number to, or greater than, itself. The last horizontal row in the table shows the number of children now living per one hundred of the parental group. We do not know how many of these offspring have reached maturity, say twenty-three years. It seems likely that the average age for those whose parents graduated between 1885 and 1894 lies somewhere between twenty and thirty years. Ignoring the period 1870-'74, where the numbers are small, one might reasonably venture the guess that the aggregate of children living to twenty-three or four years will not exceed the parental assemblage by more than ten or twelve per cent.

Had we similar data for all the 713 male graduates of the Michigan State College in the classes from 1870-1899,

*Some families were discarded because of incomplete data concerning the number of children.

it is probable that the showing would not be so favorable, for the following reasons: (1) The percentage of unmarried would doubtless exceed the two or three per cent which we have found. This aggregation of single men would swell the parental group, but would provide no children. (2) The less vigorous shorter-lived parents, with their probably somewhat smaller and earlier dying families, would then be included. (3) Possibly some persons failed to answer our questionnaire because they are not interested in children or problems concerning them. Such persons would be likely to have small families. For these reasons, if we had complete data for the families of the 713 male graduates, the ratio of surviving adult children to the parental group would probably be less than the corresponding ratio for the 574 persons whom we have studied*

To summarize: It is probable that the sum total of graduates of the Michigan State College in the classes from 1870 to 1899 has not much more than reproduced itself, if it has done that. During this period the population of the United States nearly doubled.[14] Our findings are in general agreement with the observations on birth rates among the graduates of other colleges. It is interesting to note that, though many of the alumni of Michigan State College came from rural districts, this has not been reflected in an elevated birth rate. This more than ordinarily capable section of the population has probably not increased much, while the population of the United States as a whole has rapidly grown. The birth rate, therefore, in the families of these alumni has been unsatisfactory.

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TABLE I

Total male graduates in the classes from 1870-'99	713	
Number of male graduates living	518	(72.7%)
Number of questionnaires mailed (many addresses unknown)	447	
Number of questionnaires returned	359	(80.3%)

TABLE II

Married and Single Graduates

Period of graduation	1870-'74	1875-'79	1880-'84	1885-'89	1890-'94	1895-'99
Number single	0	1	1	1	1	2
Number married	19	38	61	80	82	77
Percent married	100.0	97.4	98.4	98.8	98.8	97.5
Average age at marriage	29.4 yrs.	27.5 yrs.	29.2 yrs.	28.6 yrs.	28.3 yrs.	28.8 yrs.
Percent childless marriages	10.5	10.5	13.3	15.0	13.6	14.3

TABLE III

Children per Married Male Graduate and per Male Graduate

Period of graduation	1870-'74	1875-'79	1880-'84	1885-'89	1890-'94	1895-'99
Children per married male graduate	3.6	2.4	3.0	2.3	2.5	2.3
Children per male graduate	3.6	2.3	2.9	2.3	2.4	2.2

TABLE IV

Period of graduation	1870-'84	1885-'99
Children per married male graduate where the total number of children in the family is known	(86 families) 2.86±.19	(198 families) 2.37±.09
Children per male graduate. Includes all single alumni reported, and all married alumni in whose families the total number of children to date is known	(88 individuals) 2.80±.19	(202 individuals) 2.32±.09

TABLE V

Comparison of Parental Group with the Computed Number of Children Who Will Probably Attain 20-25 Years of Age

Parental group (husbands, wives, and single men)				574
Total children born, excluding stillbirths				716
Number of children expected to survive to 20 years	Glovers data,		1901	552
	"	"	1910	573
Number of children expected to survive to 23 years	"	"	1901	542
	"	"	1910	564
Number of children expected to survive to 25 years	"	"	1901	535
	"	"	1910	558

TABLE VI

Period of parent's graduation	1870-'74	1875-'79	1880-'84	1885-'89	1890-'94	1895-'99
Children born	43	77	126	162	172	136
Children now alive	33	68	97	151	157	120
Parental group	24	65	85	139	141	120
Number of children now alive per 100 of parental group	138	105	113	109	111	100

BUD SELECTION IN THE WASHINGTON NAVEL ORANGE

III. Progeny Tests of the Australian Strain

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PRELIMINARY studies of bud variation in the Washington Navel orange and of strains originating from these variations have been previously reported.[1] An account of the origin of the Unproductive strain of the Washington Navel orange and performance records of progeny trees of this strain have already been published.[2] Data have also been presented showing the inheritance through bud propagation of differences in quality of fruit which have arisen as limb variations in trees of this same variety[3].

The Australian strain of the Washington Navel orange is being eliminated from commercial culture in the Southwest on account of its lack of production and the poor quality of its fruit. The origin of this strain and performance records of progeny trees propagated from Australian limb and tree variations will be discussed in this publication.

The Australian Strain

Trees of the Australian strain are rank-growing and have a characteristic upright habit of growth. If not pruned excessively they stand up above the normal trees of the Washington strain and can be easily distinguished by reason of their large size as shown in Figure 8. They produce light crops of inferior fruits which show marked variations in shape, size and other characteristics, so that their presence in a commercial orchard is undesirable and they tend to make it unprofitable. Light yields and vigorous vegetative growth seem to be correlated characters of these trees. Efforts to induce fruitfulness by severe pruning or other similar treatment have failed to improve production, the only effect being continued vegetative development. The name "Australian" appears to have been applied to trees of this strain on account of their similarity to those grown from some of the early navel orange instroductions from Australia.

This strain as commonly designated really includes three classes of trees which are similar in their foliage characteristics and habits of growth but differ in the general types of fruit which they produce.

The Australian fruits may be classified as (1) the Small Australian which resemble normal Washington fruits except as to size and quality, as shown in Figure 10. (2) the Coarse Australian, of large size, light color, coarse texture of rind, globular shape with coarse, abundant rag and juice of inferior quality (see Figure 9), and (3) the Wrinkled Australian, of small size, usually flattened at the stem and distal ends with a peculiar wrinkled appearance about the stem end, as illustrated in Figure 11. The frnits are seedless and frequently develop large navels, which in many instances form protuberances which detract greatly from the appearance and market value of the fruit.

Tests of the sugar-acid ratio of the juice of the fruits from Australian trees have shown that they do not reach the market standard of maturity until from two to three months after those from trees of the Washington strain in the same orchard. In view

of the difficulty and additional cost of harvesting isolated trees, the Australian trees are usually picked at the same time as those of the Washington strain. As a result of this practice such crops are often packed with some of the Australian oranges included and the presence of these immature fruits tends to lower the value and market reputation of the crop as a whole. On the other hand if these late ripening fruits are discarded they are a total loss to the growers.

The fruits of the Australian strain on account of their late ripening, light color and rough texture of rind, extremely small or excessively large size, unusual shape, insipid juice, abundant rag and lack of uniformity are markedly inferior in commercial value to the fruits of the Washington and Thomson strains.

Accidental Propagation of Australian Bud Variations

Australian limb variations have frequently been found in established orchards in trees that are otherwise typical of the Washington strain. These limb variations develop an excessive number of vigorous growing branches commonly called suckers and bear fruits which are usually of undesirable size, texture and juice content. From the fact that sucker-growth was extensively used for propagation until recent years it is evident that the presence of trees of the Australian strain in orchards of the Washington Navel orange was undoubtedly due to the use of sucker-growth budwood from Australian limb variations. This fact has been fully proven in studies by the writers in commercial nursery propagation and individual tree performance record work in orchards of known parentage.

Thousands of Australian trees in established orchards have been successfully top-worked during recent years with selected budwood. These buds when inserted in healthy trees have usually made satisfactory growth and have produced trees typical of the Washington strain. From three to five years have been required, as a rule, to bring these rebudded trees to the normal production of comparative trees of the Washington strain. The other plan for eliminating the Australian trees in existing orchards has been to pull them out during the autumn or winter months and to replant with young nursery trees propagated from carefully selected buds. Experience indicates that top-working has given the most satisfactory results thus far in the case of healthy young Australian trees, while replanting has proven to be most efficient with older trees of this strain.

Progeny Tests of Bud Variations

In order to determine whether or not the strains of the Washington Navel orange originating from bud variations may be perpetuated through budding, propagations were made in the spring of 1915 of a number of limb variations and of trees grown from such variations which were typical of the important strains of the Washington Navel orange. The buds from these sports were inserted on sour orange root-stocks and the trees were grown in co-operation with the Citrus Experiment Station of the University of California.

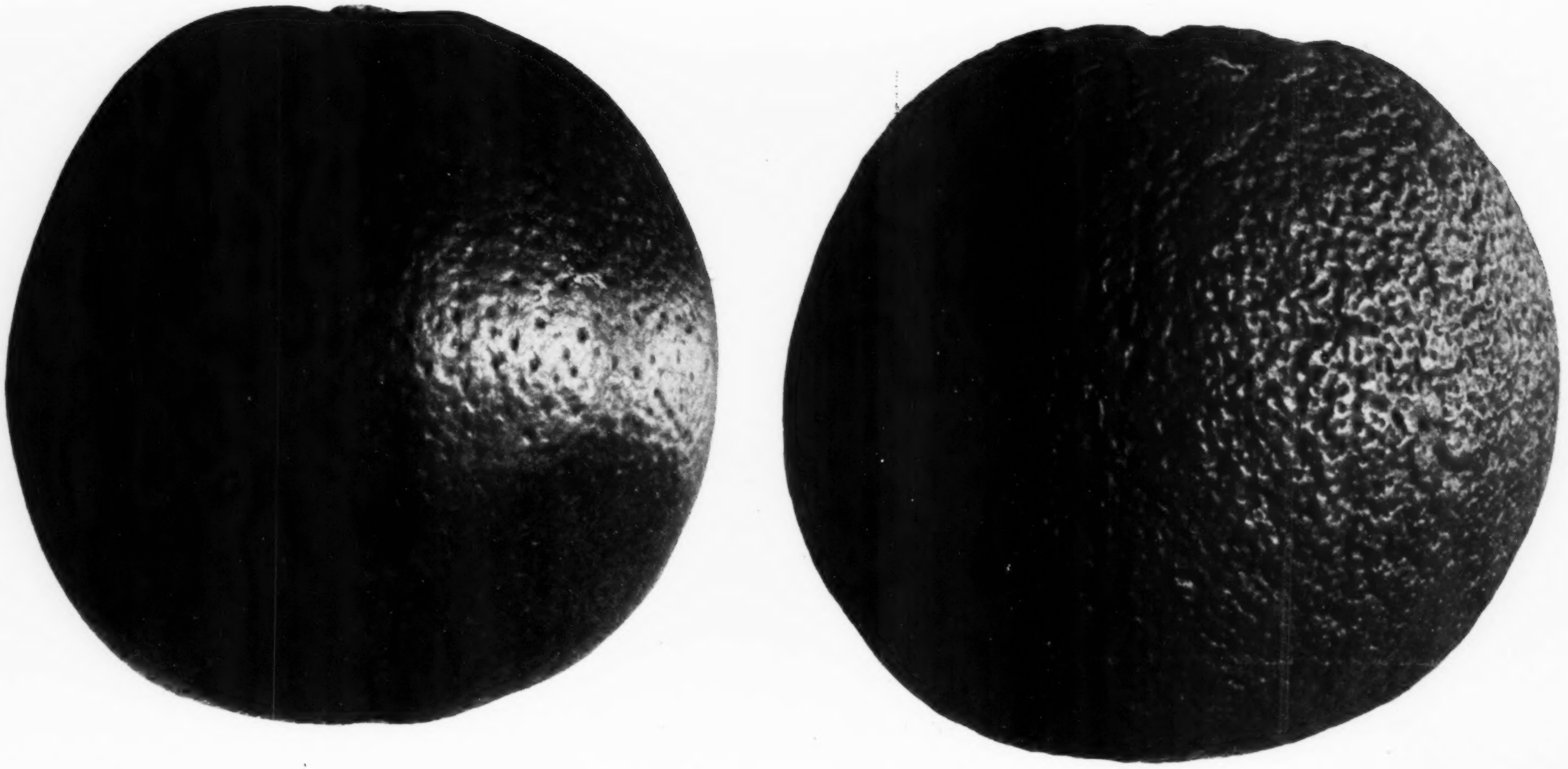
In July, 1917, these progeny trees were planted at the Citrus Experiment Station, Riverside, California. They were placed at intervals of ten feet in rows twenty-two feet apart. This close planting in the row made it possible to test more progenies than could have been done with ordinary spacing. The trees have been given normal cultivation, irrigation and other cultural care. Winter and summer legume cover crops have been grown each year with more than ordinary success and have been plowed under for the purpose of improving the soil conditions. The progeny trees have made a normal and healthy growth and have not suffered from serious frost dam-

Washington Australian

PARENT AND PROGENY TREES—AUSTRALIAN LIMB VARIATION

Figure 8

The upper part of the cut shows one of the parent trees of the strain that was studied in this investigation, and across from it a tree of the normal Washington Strain. Progeny trees propagated from both of these trees are shown below. Here the rank habit of growth of the Australian tree, and its lack of fruit, are both very evident.



THE COARSE FRUITED TYPE

Figure 9

The Washington fruit at the left is from the normal part of the tree which had a limb variation bearing fruits like that shown at the right. The three types of limb variations classified as "Australian" are grouped together rather on account of their growth habits than because of any similarity of the fruits.

age, insect attack or other causes of tree injuries.

Progeny Propagation of the Australian Strain

Propagations were made from four selected Australian trees which had been under observation for several years, from one comparative tree of the Washington strain, from two Australian limb variations in trees of the Thomson strain and from the normal portion of one of these latter trees. Two of the selected Australian trees were typical of those producing small fruit similar to those of the Washington strain but of inferior quality as described above. One of these trees is shown in Figure 8 with the comparative tree of the Washington strain from which progeny trees were grown. The third Australian tree was of the coarse-fruited class and the fourth one was of the wrinkled class. The Australian limb variations from which propagations were made were also of the wrinkled class.

The nursery trees from these propagations were set out in the progeny orchard on July 2, 1917. Two progeny trees from each Australian parent tree and limb variation were planted for this test with the exceptions shown in Table 1. The environmental conditions have been similar and uniform for all of these trees.

The production of the individual progeny trees has been recorded each season in terms of the number of fruits borne and these data are shown in Table 1. The progeny trees numbered one to seven inclusive, stand adjoining one another in the same orchard row. One of the Australian progeny trees propagated from tree 63-9 (small-fruited) and the comparable Washington progeny tree are shown in the lower part of Figure 8.

Discussion of the Data

The two progeny trees of the Australian parent tree 63-9 produced total yields of 119 and 153 oranges respectively for the five year period 1920-21 to 1924-25 inclusive. The small fruits borne by the progeny trees were all typical of those produced by the parent tree and were of inferior commercial value.

In comparison with the yields of the Australian progeny trees the Washington progeny tree has produced a total of 935 oranges. These fruits have been of good size, smooth texture, superior juice content and typical of the Washington strain. It is apparent that the Washington progeny tree has consistently produced heavier yields than have the Australian trees and that the yield characteristics of each of the parent trees have been transmitted to their progeny.

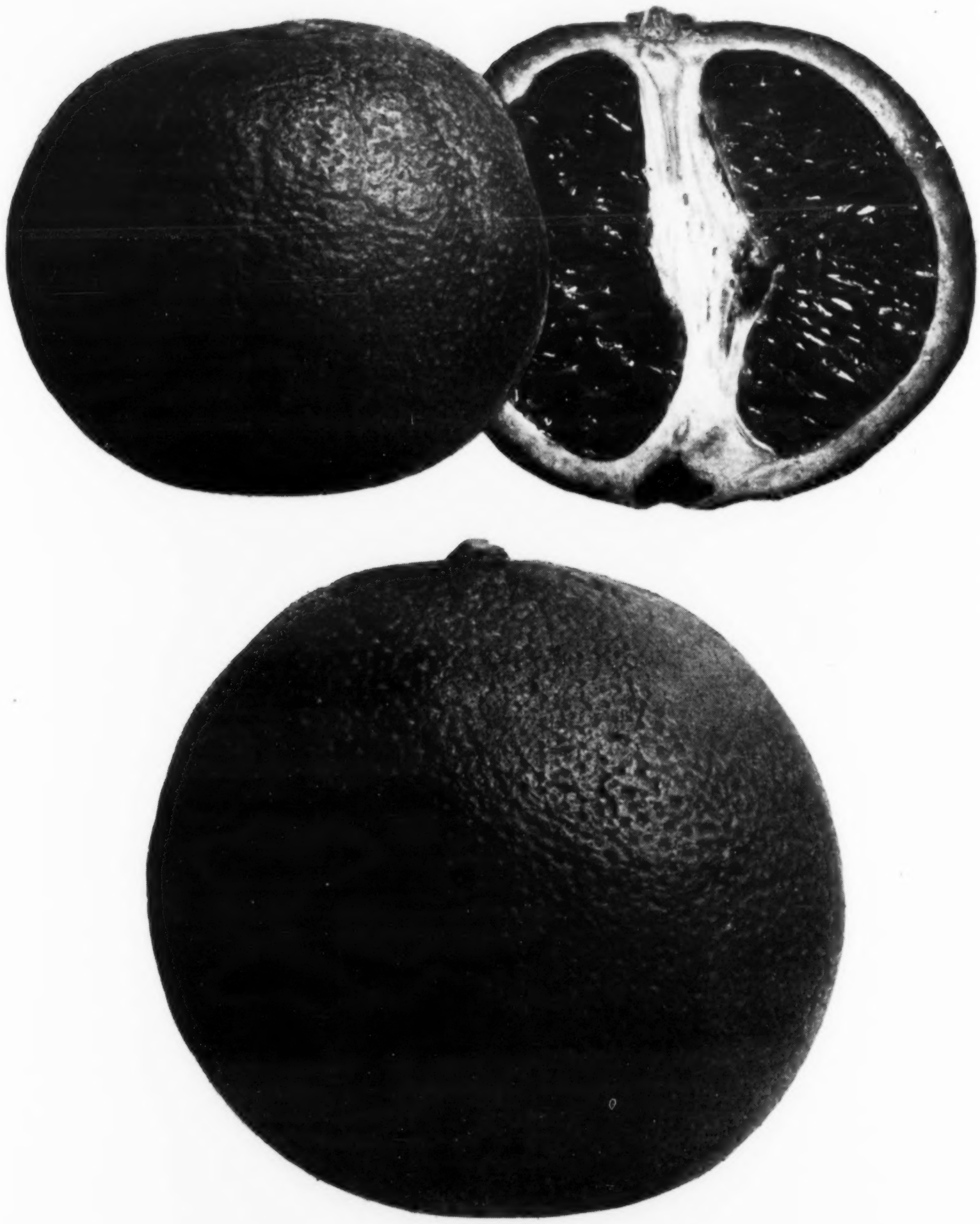
The two progeny trees of the Australian parent tree 69-5 produced total yields of 73 and 171 oranges during the performance record period and all of them were typical of those produced by the parent tree, of small size but otherwise resembling Washington strain fruits.

The two progeny trees of the Australian parent tree 71-5 produced total yields of 134 and 135 oranges respectively during the five year period. The fruits were all of coarse texture, large size, light orange color, very inferior in juice content and typical of the parent tree fruits.

The two progeny trees of the Australian parent tree 7-18 produced total yields of 218 and 194 oranges respectively for the five year period. The fruits were typically Australian in character, the most of them being of small size, flattened shape, wrinkled about the stem ends and of inferior juice content and low commercial value.

The progeny trees grown from the Australian limb variation in parent tree 31-13 produced during the five year period total crops of 299 and 523 fruits respectively, which were typical of the Australian strain.

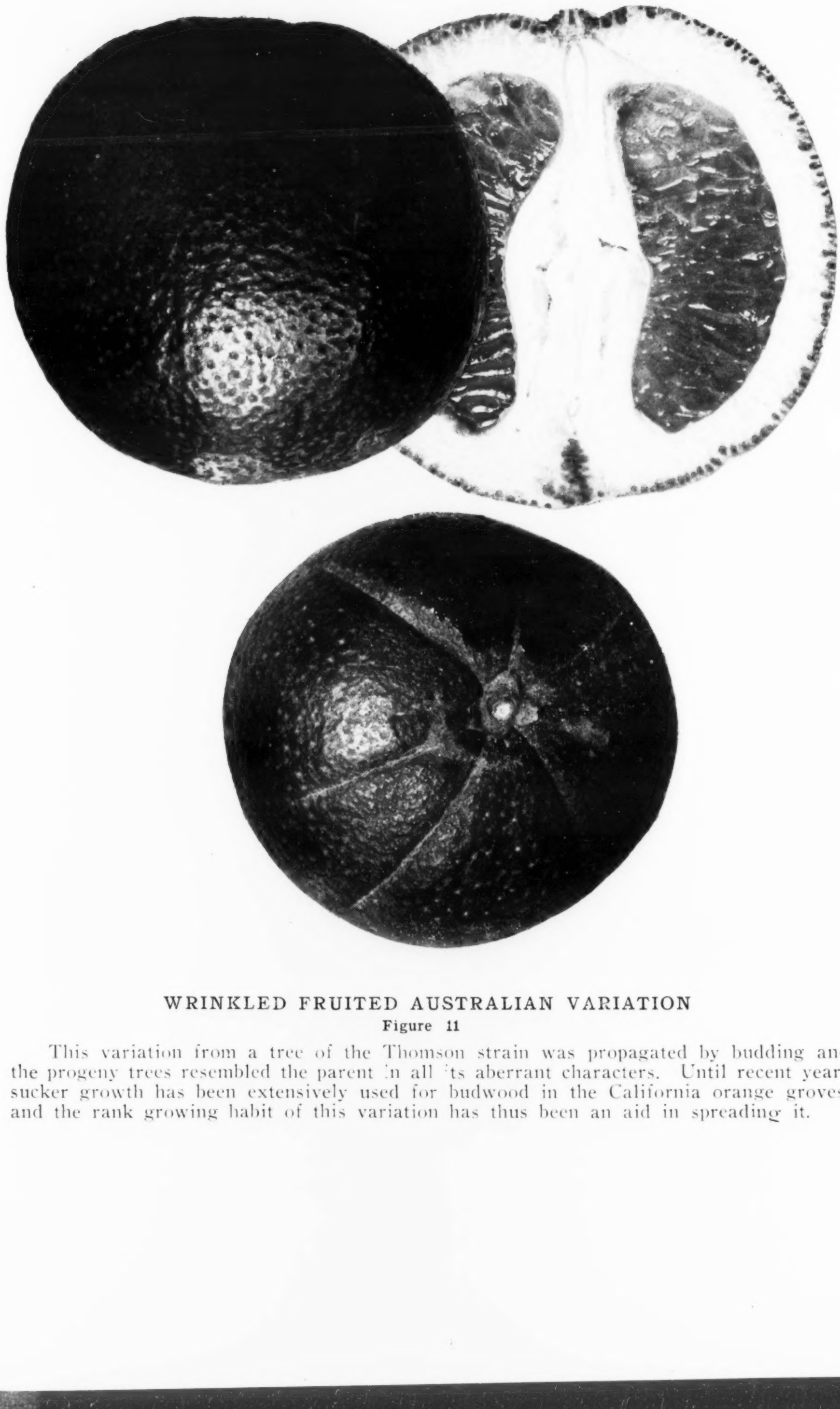
The progeny tree grown from the Australian limb variation in parent tree 3-18 produced a total of 378 fruits



SMALL FRUITED AUSTRALIAN ORANGES

Figure 10

Fruits from a limb variation of a Washington Navel tree with a normal orange from another branch of the same tree shown below for comparison. This bud variation was propagated and all fruits on the progeny trees were of the Australian type.



WRINKLED FRUITED AUSTRALIAN VARIATION

Figure 11

This variation from a tree of the Thomson strain was propagated by budding and the progeny trees resembled the parent in all its aberrant characters. Until recent years sucker growth has been extensively used for budwood in the California orange groves, and the rank growing habit of this variation has thus been an aid in spreading it.

during the five year period, all of which were typical of those borne by the parent limb.

The two Thomson progeny trees propagated from the normal portion of parent tree 3-18 produced total yields of 892 and 556 oranges respectively, all of which showed the typical smooth texture, deep color and coarse flesh of the Thomson strain fruits.

Conclusion

These results indicate that the quantity and quality of fruits produced by citrus trees are transmissible characters occurring as bud variations and as such are capable of perpetuation through budding.

These performance record studies show that the characteristics of trees of an unproductive strain are perpetuated through bud propagation and that the presence of such trees in established orchards may be due to the unintentional propagation of bud variations of this character.

These facts and the results of similar tests previously reported demonstrate in a most emphatic manner the fundamental importance of systematic bud selection in the commercial propagation of citrus trees in order to avoid the perpetuation of strains that are low in production and poor in quality of fruit.

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TABLE I—Records of annual production of progeny trees propagated from four trees of the Australian strain, one tree of the Washington strain, two Australian limb variations in trees of the Thomson strain and the normal portion of one of these Thomson trees. The fruits produced by these progeny trees have been typical of the strains that were propagated.

Strain	Progeny Tree No.	1920-21	1921-22	1922-23	1923-24	1924-25	Totals
Progeny of Australian tree	1	0	13	30	76	0	119
63-9, small-fruited class	2	2	51	37	63	0	153
Progeny of normal Washington tree 64-7	3	30	125	127	503	148	935
Progeny of Australian tree	4	16	0	6	51	0	73
69-5, small-fruited class	5	0	13	53	105	0	171
Progeny of Australian tree	6	1	59	46	28	0	134
71-5, coarse-fruited class	7	1	23	48	63	0	135
Progeny of Australian tree	8	10	89	31	60	28	218
7-18, wrinkle-fruited class	9	18	81	23	67	5	194
Progeny of Australian limb variation in Thomson tree	10	9	64	31	165	30	299
31-13, wrinkle-fruited class	11	24	75	87	258	79	523
Progeny of Australian limb variation in Thomson tree 3-18, wrinkle-fruited class	12	13	46	75	138	106	378
Progeny of normal Thomson	13	30	198	112	374	178	892
portion of tree 3-18	14	23	177	44	184	128	556

BRITISH COTTON RESEARCH IN TRINIDAD

Report of Empire Cotton Growing Corporation

A COTTON research station for the British Empire is being established in the West Indies in the Island of Trinidad, by the Empire Cotton Growing Corporation. A report* has been published by the corporation, which states the reasons developed for settling upon Trinidad as the most suitable location in the British Empire for such an institution, after several years of deliberation. Also the report includes a summary of the problems to be investigated, which may be of interest to plant breeders and experimenters in the United States.

There are many fundamental problems connected with the cotton plant and with the properties of its lint, the investigation of which does not fall within the duties of the scientific specialists on the Agricultural Staff of any single cotton-growing country, who have not, moreover, as a rule, had the requisite training to fit them for such work, nor have they the time to do it if they had. Since, however, the successful solution of such problems may be confidently expected to lead to results of the highest value to the cotton industry, the corporation intends to establish a Central Research Station, whose special function shall be the study of such problems rather than the investigation of local difficulties, which in most instances can better be studied in the country in which they originate.

Prior to recommending the establishment of one central station, the corporation considered very carefully the possible alternative of subsidizing institutions in different parts of the Empire to carry out research work on the cotton plant. The reasons which led them to reject this alternative were briefly as follows: if the work is not concentrated at a central station it is impossible to focus it on a common line of attack on any particular problem, nor can there be effective cooperation between the different branches—e. g., genetics and physiology. Secondly, results and records would be scattered, thus making continuity of record impossible and reference by other workers difficult. Thirdly, there would be no one recognized place to which problems could be referred for investigation from the different parts of the Empire, and there would be no possibility of ascertaining the precise conditions under which any particular result was obtained, and of repeating those conditions in another experiment, whereas these would be standardized and recorded if there were only one central station. Apart from these reasons, there are obvious practical difficulties: the research workers in cotton-growing countries are all fully occupied on local problems, mostly in connection with the plant breeding and selection work for the immediate practical purpose of improving the seed supply of the localities in which they work. The corporation would, therefore, be faced with the impossible task of providing additional suitably qualified research workers at each of the institutions which it was decided to subsidize, instead of having to staff only one central station. Moreover, the facilities for research, where they exist at all, are already fully taxed, so that considerable expense would have to be incurred in extending the laboratories at each place. The further disadvantages that might result from having a Research Station near commercial cotton crops are referred to below.

As regards the site for the Research Station, the corporation considers that so long as most types of cotton can be grown in the place selected, it is of less importance whether the conditions are typical of any large area of potential cotton-growing country, for the following reasons: firstly, in any large area of potential cotton-growing country cotton would almost certainly be already grown as a commercial crop, or would be so grown in the future, and the establishment of a Research Station and the consequent introduction, for experimental purposes, of many different types of cotton would almost inevitably give rise to economic difficulties owing to the danger of hybridization of the commercial varieties with others

*A Cotton Research Station for the British Empire, Being a Summary of a Report to the Empire Cotton Growing Corporation, by Prof. J. B. Farmer, F.R.S., and Mr. L. G. Killby, with a foreword by Dr. W. L. Balls, F.R.S. The Empire Cotton Growing Corporation, Millbank House, Millbank, London, S. W. 1, 1925.

grown at the Research Station, unless there were exceptional facilities for isolation of the experimental crops, and special care were exercised in the disposal of their seed. In addition, it is only too likely that any fresh troubles from pests or diseases that might develop in the commercial cotton crops would be laid at the door of the Research Station which, however unjustly, would be thus brought into local disrepute.

Secondly, it is a matter of general knowledge that whenever cotton raised in one place is transplanted to another, the effect of acclimatization can only be determined by experience. Whether, therefore, the conditions at the Research Station are characteristic of large, or only of small, areas of cotton-growing countries, this acclimatization effect will, in either case, have to be reckoned with in growing elsewhere cottons raised at the Research Station. On these grounds the corporation attached greater importance to other factors, including those mentioned below, in the selection of a site.

In the first place, the corporation set themselves the task of defining what are the determining factors by which their choice should be governed; they agreed upon the following: (a) suitability of the site selected to grow cottons of many different kinds; (b) accessibility from England; (c) good climate for scientific workers; (d) availability of intelligent field assistants; (e) proximity to an existing university or college. Having regard to the fact that the corporation's chief activities are in Africa, they first examined the suitability of possible sites in that continent. The Sudan was rejected mainly on the ground of its trying climate and the special conditions under which the plant is there grown in the irrigation areas; the Transvaal and Natal, partly owing to the comparatively long and expensive journey from England. The corporation attached great importance to the advantages to be derived from close proximity to a university or college of standing, but it does not appear that Pretoria itself, which alone could provide close contact with the university there, is advantageously situated for that purpose, lying as it does at an altitude of 4,471 feet above sea-level. Outside Africa, Ceylon and Cyprus were among the other places whose claims were fully discussed, but, though possessing certain advantages, these were out-weighed by their drawbacks.

After thus exhaustively examining the possibilities of several different parts of the Empire, it was agreed that Trinidad might be found to possess more advantages and fewer disadvantages than any other place that appeared in any way suitable for the purpose.

The fact that the Imperial College of Tropical Agriculture in Trinidad had recently appointed as their new principal, Dr. H. Martin Leake, and that Dr. S. C. Harland was professor of botany, there was naturally a factor in favor of Trinidad, since the valuable research work on cotton that has already been done by Dr. Leake in India and by Dr. Harland in the West Indies and in this country is universally recognized, and it would consequently be a great advantage to the Research Station if it were so situated that they could interest themselves in its work. . . . . .

On whatever scale the work of the Central Research Station is planned, it must be remembered that the results there obtained will not necessarily, or even probably, be found to hold without modification in other regions, where the soil and climate may be very different. But the basic principles discovered will be of wide application; and for this reason it will be necessary that the station shall be central not in name only, but shall serve as a means of suggesting appropriate investigations to be conducted in other cotton-growing lands, where the different factors (of climate, soil, and the like) that may influence the actual behavior of the cotton plant in such countries may be carried out, perhaps under advice from the central station. Even qualities of cotton that may be regarded as "genetically fixed" may be found to be affected by climatal variation, and such matters will form proper problems for further elucidation. This touches on the whole question of acclimatization, concerning which much remains to be learnt. We visualize the possibility of members of the staff in the central station being detailed for service to solve special problems elsewhere, and with the accumulating experience that such a station should be in a position to gather, such mutual contact must prove of advantage to the cotton-growing industry as a whole. . . . . .

The scientific work that has already been done on the cotton plant and its lint has emphasized how much still remains to be elucidated in the fundamental conditions which govern the growth of the plant, and influence the properties of its fibre. For example, a wide field is open for investigation on such problems as the reaction of the plant to changes of temperature and of water-supply, the causes of boll-shedding; the possibility of breeding cottons that would not easily be hybridized, or those that would be more resistant to disease; the physiological factors which lead to insufficient secondary thickening of the cell wall, and thus cause neppiness. It will readily be recognized how important a bearing the solution of such problems as these has on the question of the world's supply of cotton.

The whole history of science shows that it is impossible to predict what results may emerge from any projected piece of work. Either on the main road, or on entirely unexpected by-paths, vantage-points may be reached from which a clear view is obtained of the country ahead, and though it is seldom that any direct short cut is discoverable, it is often possible to map out with some certainty the route by which alone objective can be attained, and by means of which, when the traveller is experienced, a successful issue is well-nigh assured.

Out of such work should emerve results which will be of direct benefit to the whole cotton industry. The development in recent years of technological research is a record of the patient investigation of the fundamental scientific principles of a subject which alone has rendered possible the steps by which an industry has achieved its most important advances. . . . ."

Science for the Young

TEACHING SCIENCE IN THE SCHOOLS, by ELLIOTT R. DOWNING.. Pp. 186, price $2.00. University of Chicago Press, 1925.

In this little study, written for educators, Mr. Downing describes what is being done and what may be done to teach general science in elementary and high schools. The principles of selection and organization of materials, and actual methods of instruction are discussed. It appears that young children are most interested in animals, plants, and physical materials, in the order named. There are a few careless slips, as Faber for J. Henry Fabre, and Karl Peterson for the editor of Biometrika. The book should be useful to those for whom it is intended, and interesting to a much larger circle.

P. P.

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THE "METAMORPHOSIS" OF EUCHLAENA INTO MAIZE

G. N. Collins

THE close relationship of maize (Zea) and teosinte (Euchlæna) has been recognized since Harshberger's work on *Zea canina* in 1896. Although very unlike morphologically, the two genera hybridize freely and produce fertile offspring. It is, therefore, but natural that the origin of maize should be sought in some form of the genus Euchlæna.

It was reported in 1921 that Burbank had succeeded in deriving maize from Euchlæna as a result of eighteen years' selection. So far as I know, the only published account of Burbank's work is that of Robert H. Moulton, entitled "Changing a Wild Grass Into Corn in Eighteen Years," which appeared in the Sunday supplement of the *St. Louis Post-Dispatch* for June 12, 1921.

To anyone familiar with teosinte-maize hybrids it was obvious from the photographs that the material with which Mr. Burbank initiated his selection was a hybrid between teosinte and maize. This view was confirmed when we were informed by Dr. H. V. Jackson, of Durango, Mexico, who had supplied Mr. Burbank with seed of Mexican teosinte, that the seed furnished undoubtedly had been contaminated with maize. Dr. Jackson communicated this fact to Mr. Burbank and presented him with photographic material illustrating several stages between teosinte spikes and ears of corn derived in two generations from the hybrid seed. Since Mr. Burbank had published no description of his experiments, it seemed unnecessary to challenge the newspaper report.

More recently Blaringhem[1] reports and interprets experiments by Bento de Toledo, of Campinas, Sao Paulo, Brazil, in which results practically identical with those of Mr. Burbank are announced.

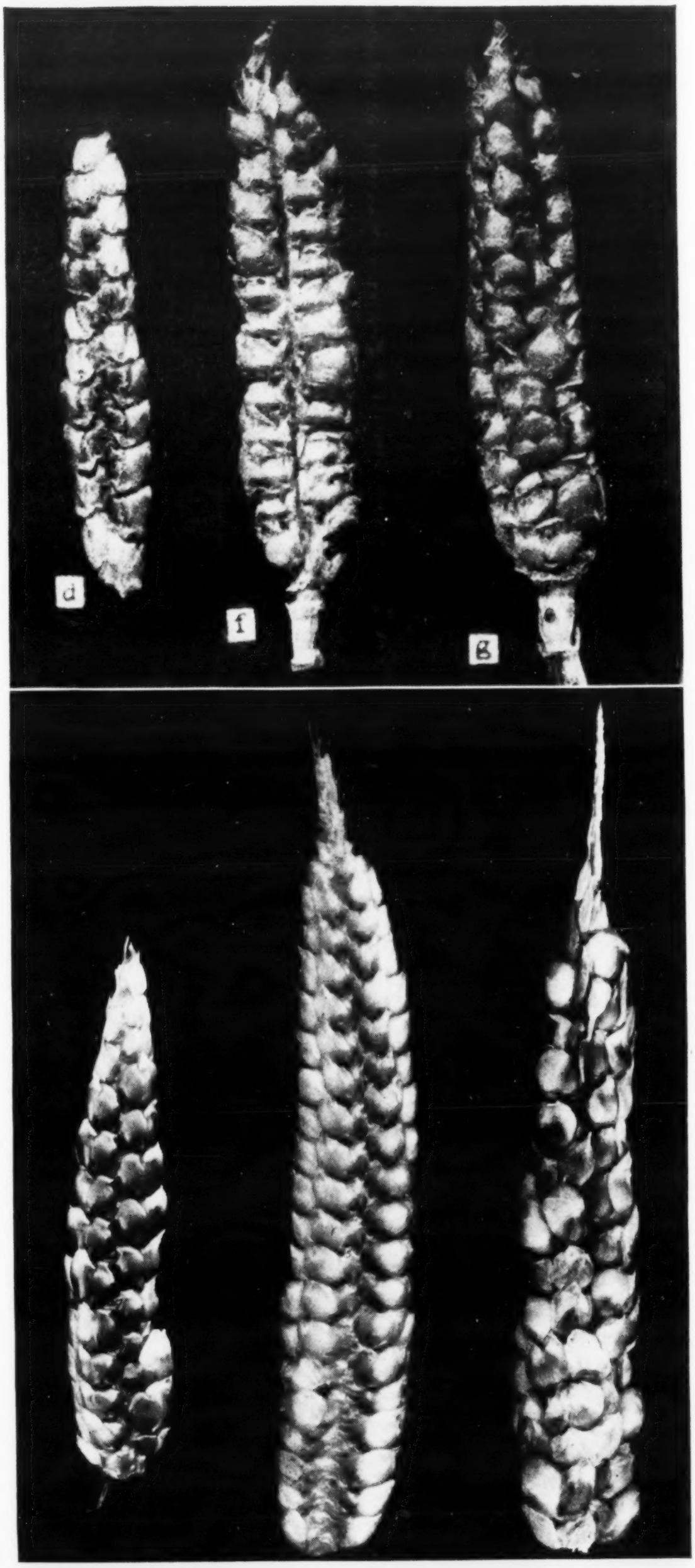
Working with *Euchlaena mexicana*, Toledo succeeded in the course of five years in deriving forms that resemble degenerate maize in all essential particulars. The intermediate stages are carefully described and figured. These are so exactly like the segregates from teosinte-maize hybrids as to arouse at once the suspicion that the Euchlæna used was contaminated with maize.

Is Annual Mexican Teosinte a Hybrid?

No statement is made regarding the source of the original Euchlæna seed, but from the description and illustrations it is clear that it belongs to the annual type growing in Mexico. The Mexican form of annual Euchlæna differs markedly from that grown in Florida. The morphology of the pistillate inflorescences is sufficiently different in the two forms to warrant their specific separation, were it not that forms resembling the Mexican type always appear in hybrids between Florida teosinte and maize. It seems highly probable that the Mexican form has resulted from crosses between maize and either *E. perennis* or the Florida type.

If this is indeed the origin of the annual teosinte of Mexico it is not surprising that one of the parental types, in this case maize, can be obtained from it by selection. It is rather remarkable, however, that progress toward the maize parent should be so

[1]Blaringhem, L. Note sur l'origine du mais. Métamorphose de l'Euchlæna en Zea, obtenue au Brézil par Bento de Toledo. *Ann. Sci. Nat. Bot.* X, 6:245-263. July, 1924: No. 3-4.



"METAMORPHOSED" TEOSINTE AND TEOSINTE-MAIZE HYBRIDS

Figure 12

The upper picture has been reproduced from Blaringhem's article, and shows three steps in the metamorphosis of teosinte into maize, as reported by Toledo. The lower picture shows three segregates of a known teosinte-maize hybrid, that have been selected as representing similar stages. Toledo's material so closely resembles that produced by crossing teosinte and maize as to leave little doubt that he is dealing with a hybrid.

rapid in the absence of recent contamination. Both maize and Euchlæna are wind pollinated and hybridize freely. Unless all pollinations have been guarded carefully it seems probable that maize pollen has been accidentally introduced in the course of the experiment.

Prof. Blaringhem follows the usual practice of referring to Euchlæna as a wild species. A word of caution is necessary in this connection. We have visited all the stations for Euchlæna in Mexico, represented by specimens in the National Herbarium. In no instances have we found Euchlæna growing in other than cultivated areas and at no great distance from fields of maize. It occurs typically as a weed in maize fields. The plant may be termed wild in the sense that it is not cultivated, but as yet evidence is lacking of its existence in nature outside of cultivated regions.

Although Florida teosinte is remarkably uniform under a great variety of climatic conditions, plants grown from Mexican teosinte seed are characterized by great diversity. Samples have been grown from numerous localities in Mexico, and in every instance there has been unmistakable evidence of recent contamination with maize.

The possibility that Toledo was dealing with a hybrid was not overlooked by Prof. Blaringhem, who concludes his paper with the statement: "This mosaic presents a perplexing problem and one may ask if we are not dealing with a hybrid between cultivated maize and true Euchlæna. This objection does not destroy the value of the essential fact that one can by selection during a few years witness the metamorphosis of a 'Euchlæna' inflorescence into an inflorescence of 'Zea'."

That maize may have originated from Euchlæna through selection may be a tenable hypothesis, but it is not apparent how this hypothesis is supported by the derivation of maize-like forms from a hybrid that has maize as one of its parents.

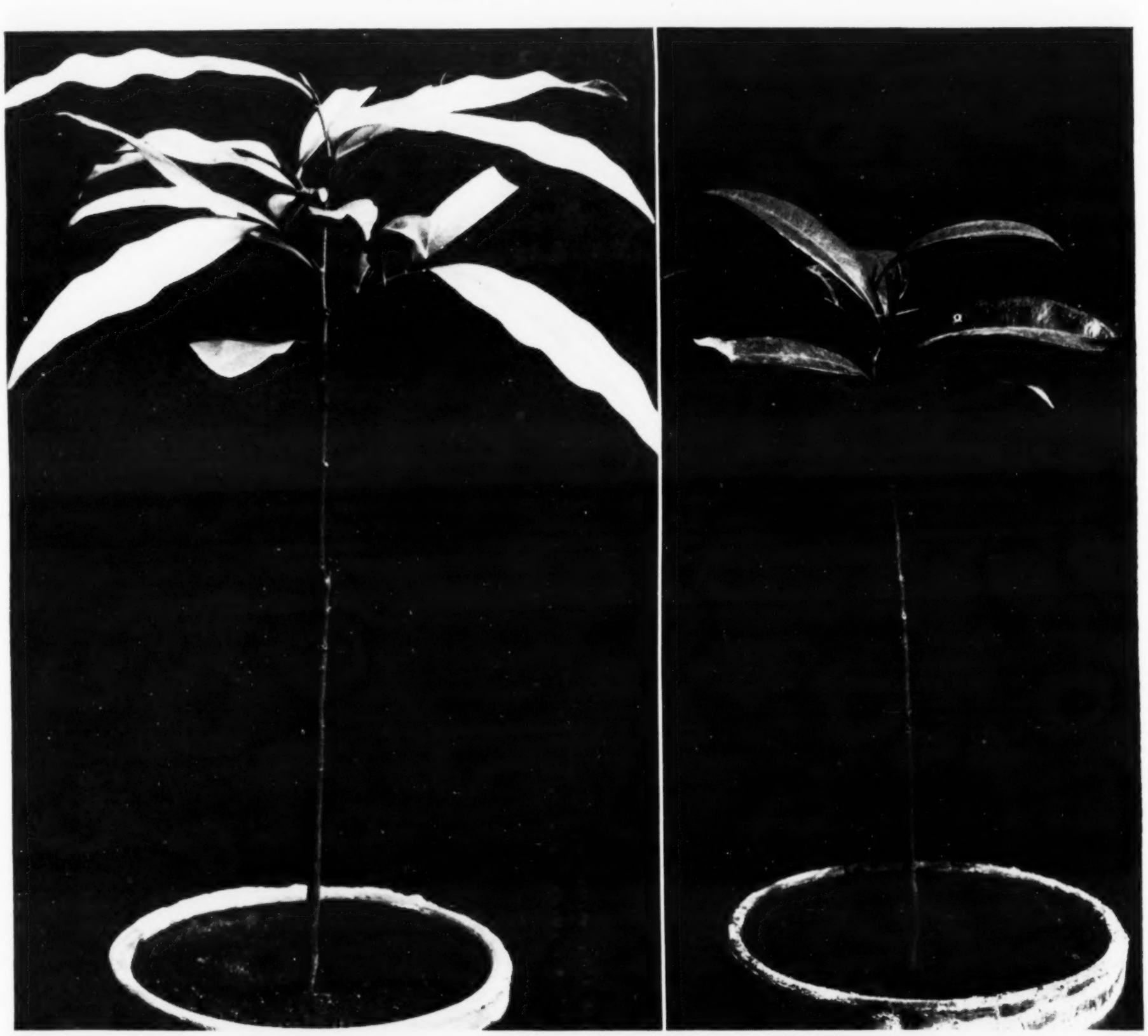
Pecan Growing

PECAN GROWING, by H. P. Stucky and E. J. Kyle. Pp. xiii + 233. Price $3.00. The MacMillan Company, New York, 1925.

This first practical manual on the culture of the pecan is well adapted to the use of growers. Geneticists will be interested in a summary of the experiences of breeders in the chapter on the history of pecan-growing and in that on the pollination of pecans. Students and investigators would have appreciated the addition of references to the literature of the pecan. Greater detail in some instances might have proved helpful. It is nevertheless a useful book. G. M. D.

A LEAF COLOR SEEDLING VARIATION IN DUGUETIA

ORLAND E. WHITE
Brooklyn Botanic Garden



GREEN AND YELLOW-LEAVED FORMS OF DUGUETIA

Figure 13

Seedlings of the same age. The seedling on the right is green-leaved and has grown much more slowly than the yellow-leaved mutant seedling on the left. Both were grown side by side in the greenhouse.

WHILE at Rio Ivon, one of the rubber stations in the Beni River country of Bolivia, the writer had the opportunity of seeing many trees of a species of *Duguetia*, a genus belonging to the custard-apple family and sometimes referred to in botanical literature as lancewood. The trees observed upon this occasion, to the extent of a hundred or more, were invariably green-leaved. Seed was collected from several of these, and upon returning to the United States, between twenty-five and fifty seeds were plant-

ed, of which only two grew. One of these produced a green-leaved and one a yellow-leaved plant. The latter, as shown in the accompanying illustration, is by far the most vigorous. The yellow-leaved seedling is in all probability a mutation, since its greater growth and robustness, as compared with the normal green seedling of the same age, largely precludes the possibility of disease. Assuming the yellow-leaved individual to be a true case of mutation, it appears worth recording as showing that even when the chances are very small such variability may take place, and further, that the mutant may grow better under the new environment than the ordinary form.

Rat and Mongoose in Hawaii

Interesting information concerning the methods adopted for rat control in Hawaii is made available by Mr. David G. Stead, a member of the New South Wales Government delegation to the recent Pan-Pacific Food Conservation Conference at Honolulu. The introduction of the Indian mongoose appears to have proved anything but a profitable measure, the animal having itself become a pest without having proved its efficacy in the way desired. "The consensus of opinion among experienced hands here," comments Mr. Stead, "is that he has proved to be a 'a very poor ratter,' while at the same time being a standing menace to poultry and bird life generally." It is appalling to think, he adds, what might happen if those in favor of the animal's introduction into Australia as a means of controlling rats and rabbits had their way.

Some years ago rats began to manifest themselves in something approaching plague numbers in Hawaiian cane fields, and—protected as they were by the forest of cane stems--they multiplied rapidly and began to destroy considerable quantities of the cane itself and of certain fruits. With the failure of the mongoose, mechanical means of control have had to be resorted to on a large scale, while poison is often freely used. A method advocated is the use of barium carbonate baits, the procedure being first to set unpoisoned wheat (in five places to the acre) for a period of about two weeks until every rat and mouse knows where it is, and then to substitute poisoned baits. This is done three times a year, with such success that the 1924 crop of cane harvested at Honokaa (an important plantation) showed practically no rat-bitten cane and the plantation got fully sixty thousand dollars worth of sugar which had hitherto gone to feed the rats. The total cost of the work here has been about five thousand dollars annually.

Another method of using the poison is to prepare a dough with one part barium carbonate to three of flour, rolling this thin, stamping it into tiny biscuits, and finally drying these and coating them with paraffin.—*Agricultural Gazette of N. S. W.*

HETEROSIS IN PIGS

Illustrated by a Double Litter*

E. Roberts and R. J. Laible

SIZE DIFFERENCES DUE TO HETEROSIS

Figure 14

The two pure bred Duroc Jerseys are the second and third pigs from the right. At six months the crossbreeds averaged nearly fifty pounds heavier than their Duroc Jersey litter mates. Since they had the same mother and were raised under exactly similar conditions, the difference is doubtless due to heterosis.

IN MARCH, 1924, a double litter of pigs was born on the farm of the College of Agriculture at the University of Illinois. The dam of these pigs was a Duroc Jersey and the sires were a Poland China and a Duroc Jersey. All of these individuals were registered animals and of excellent type. About twelve hours after the Duroc Jersey sow had mated to the Poland China boar she was mated to the Duroc boar.

The litter contained ten pigs, six of which were Duroc Jerseys and four were Poland China-Duroc Jersey crossbreds. The crossbreds were easily distinguishable by their red and black spotting. Table I gives the sex and birth weight of the pigs.

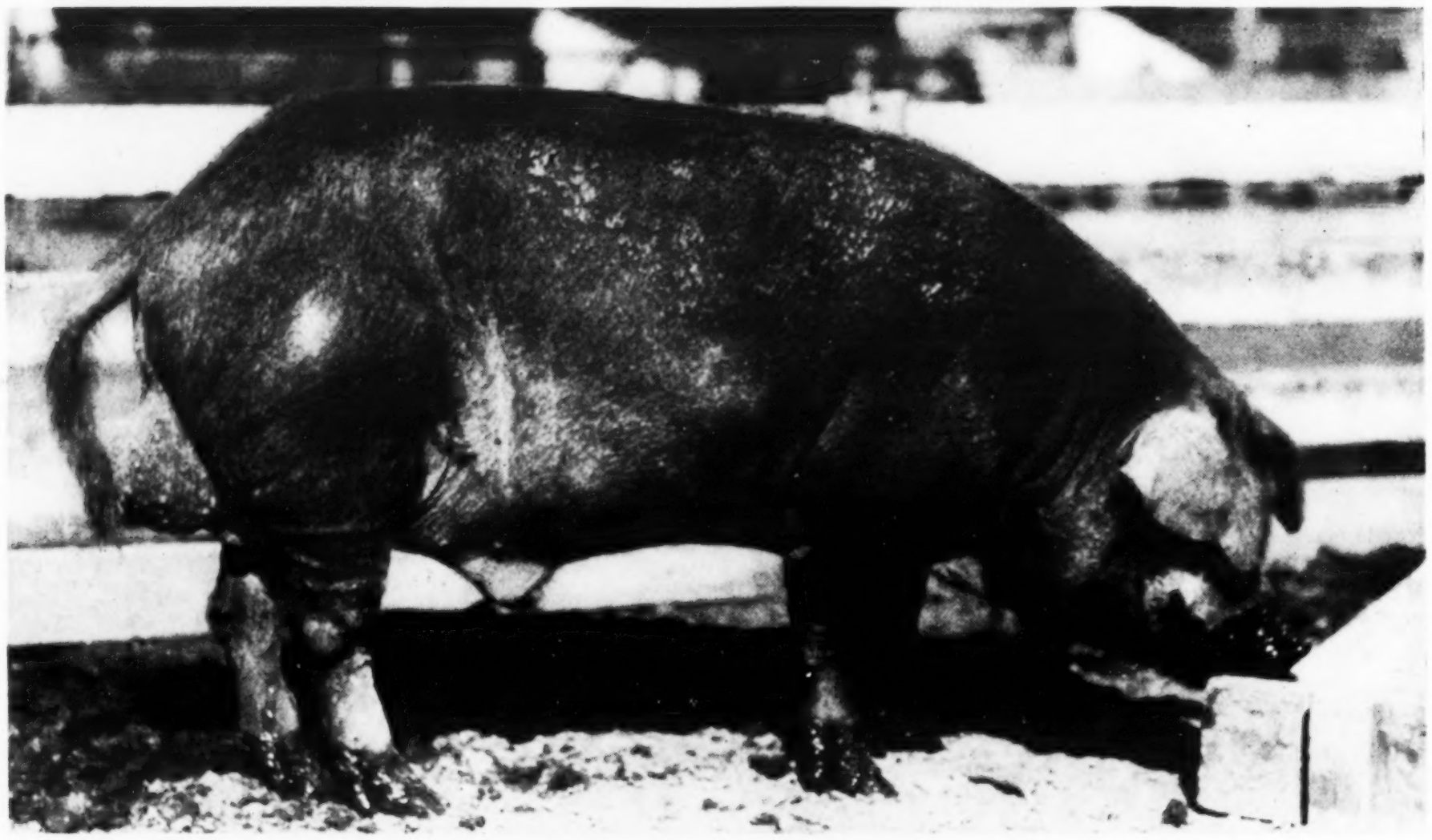
The average weight of the crossbred pigs at birth was greater than that of the pure breds though the numbers are too small for this difference to be statistically significant.

The weights at six months of age of four crossbreds and of two pure breds, four pure breds having been eliminated before this time, are given in Table II.

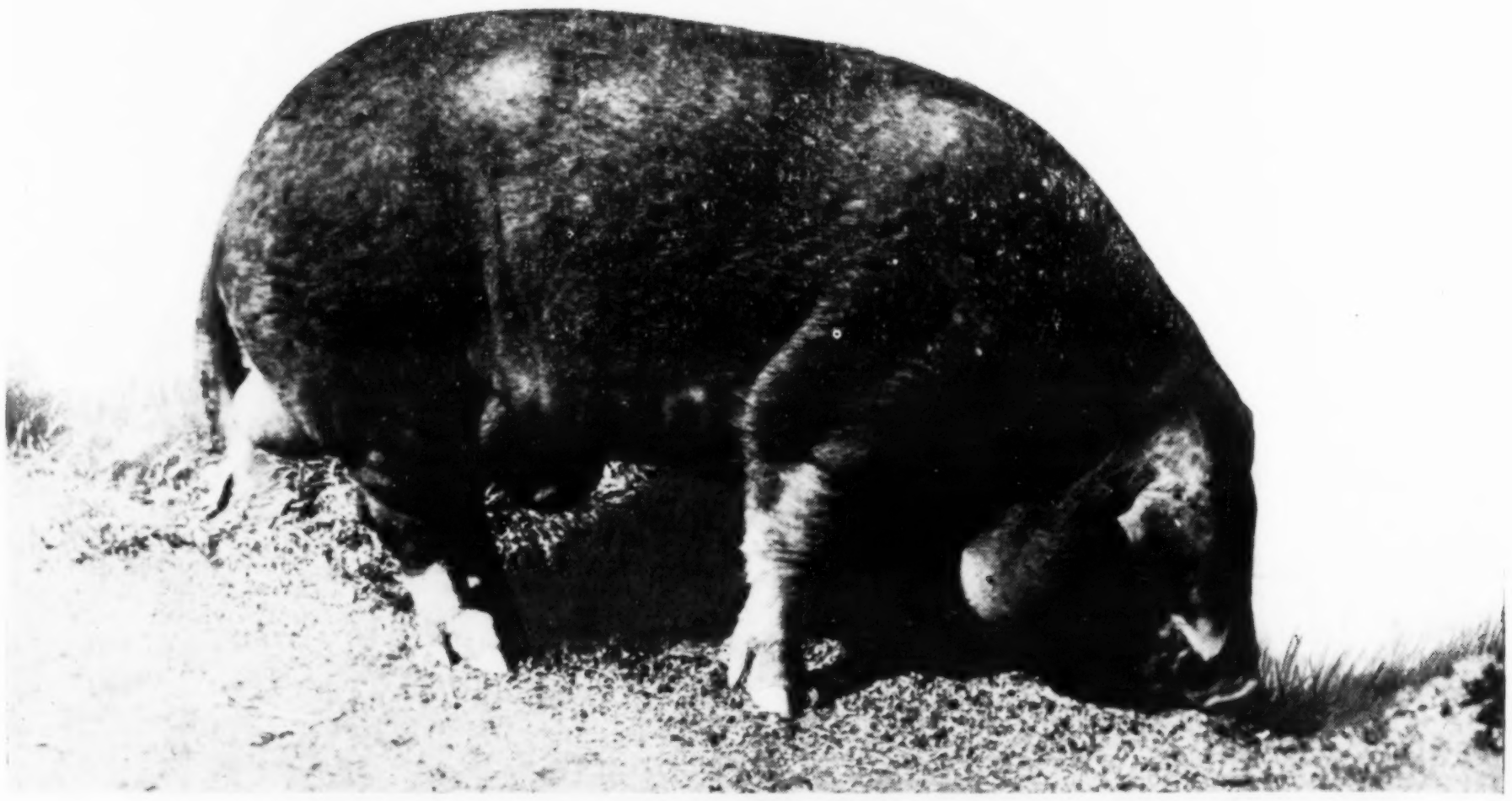
The average weight of the Duroc Jerseys was 185.5 pounds while that of the crossbreds was 235.2. All of the pigs were treated in the same way and since they had the same mother the difference is probably due to crossbreeding. However, the possibility remains that the increased size of the cross breds was due to recombination of size factors; but it is a matter of common observation and of investigation that crossbreeding often results in individuals which are more vigorous and larger than pure breds.

Since double matings eliminate so

*Paper No. 24 from the Division of Animal Breeding Department of Animal Husbandry, University of Illinois.

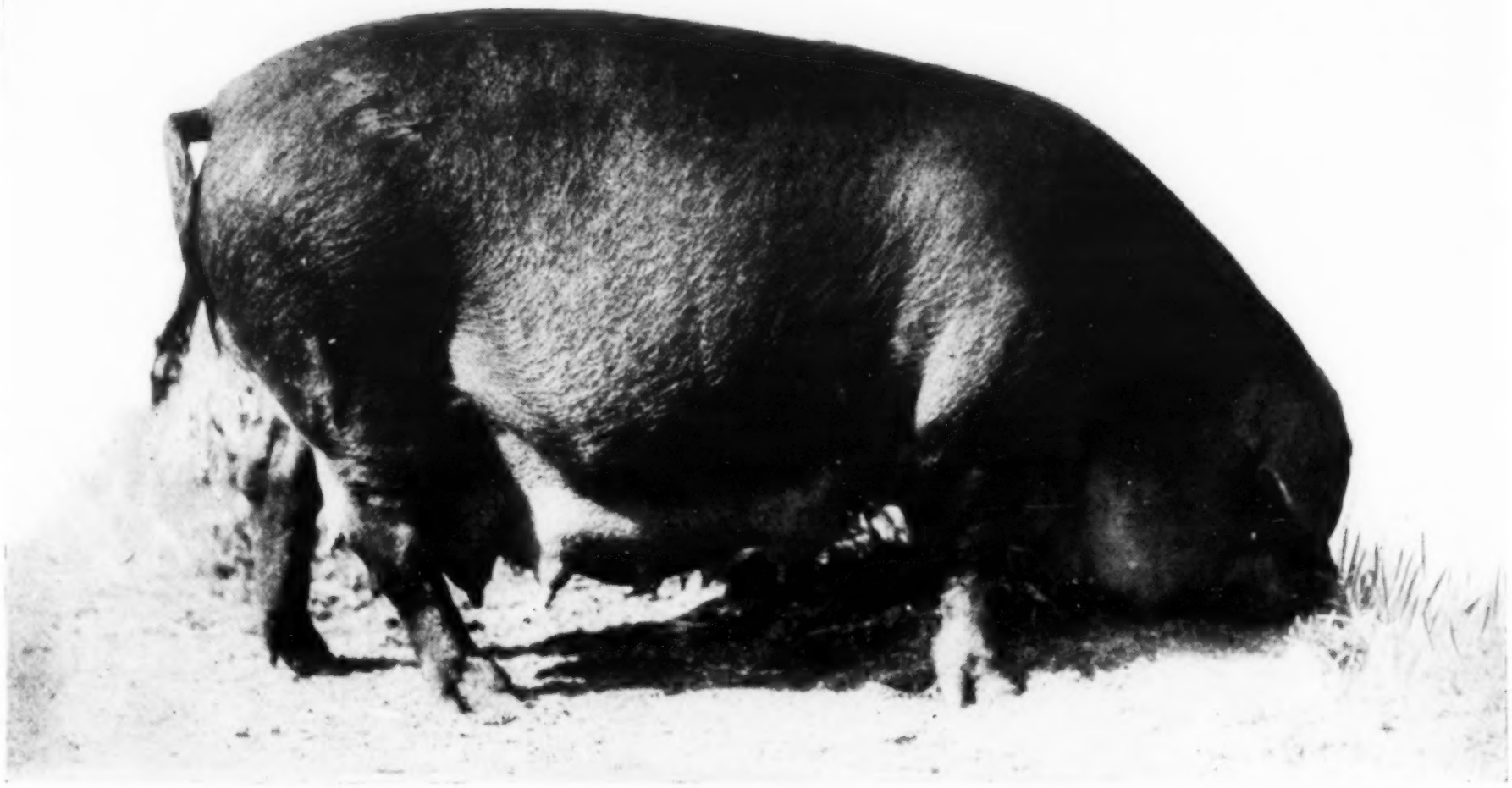


Duroc Jersey Boar



Poland China Boar

THE TWO SIRES
Figure 15



THE DUROC JERSEY SOW
Figure 16

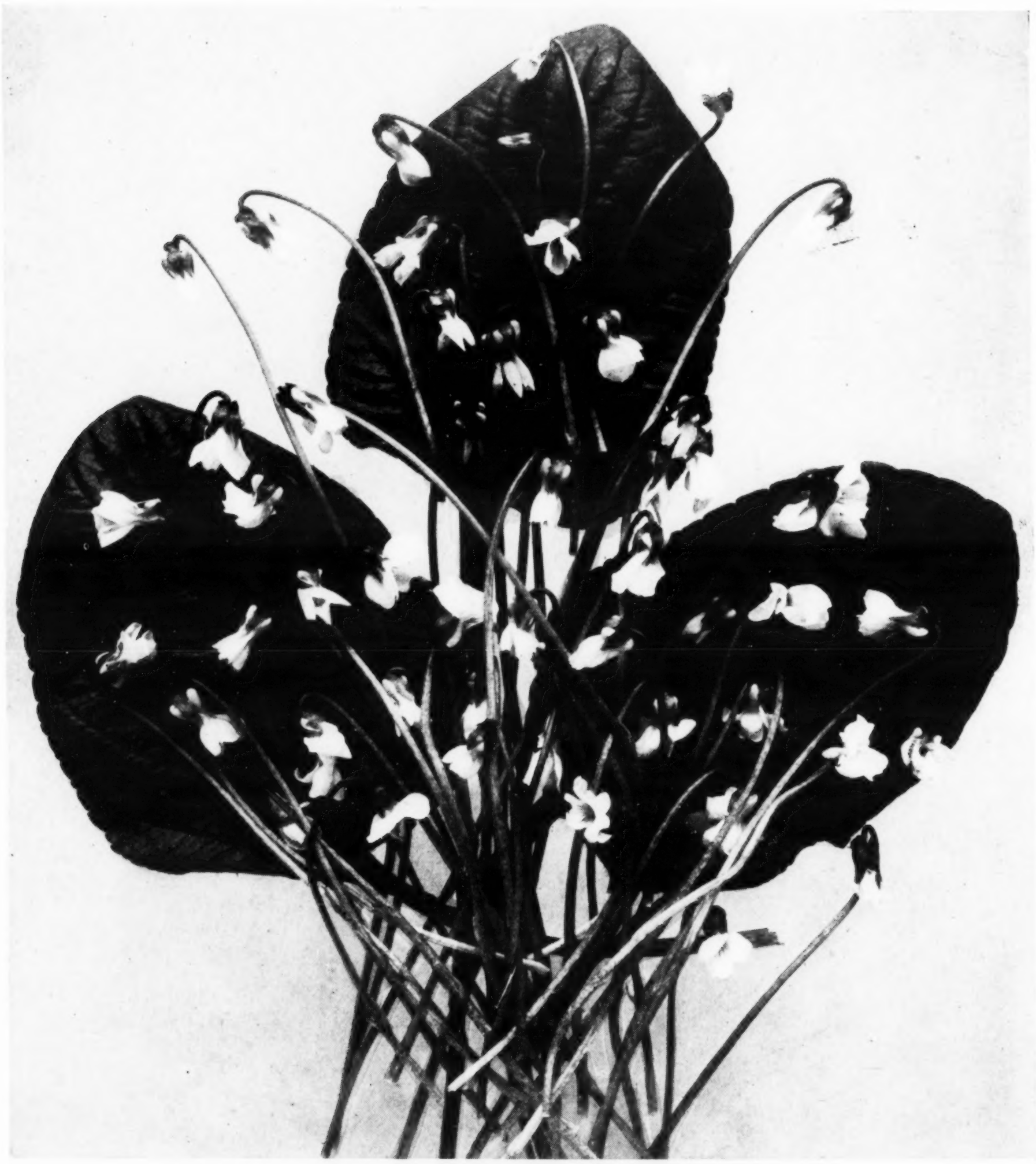
many disturbing factors the Divisions of Swine Husbandry and Animal Breeding are making use of this method in an investigation of the effects of crossbreeding upon growth and economy of production in swine.

TABLE I.—Birth weights of double litter.

Duroc Jerseys		*Crossbreds*	
Sex	*Weight at Birth*	*Sex*	*Weight at Birth*
♀	3.4	♀	4.0
♀	4.0	♀	3.9
♀	2.0	♂	3.1
♀	3.2	♂	4.0
♂	4.0		
♂	2.8		
Average Weight	3.23	Average weight	3.75

TABLE II.—Weight of double litter at six months.

Duroc Jerseys		*Crossbreds*	
Sex	*Weight*	*Sex*	*Weight*
♀	188	♀	231
♀	183	♀	225
		♂	261
		♂	224
Average	185.5	Average	235.2



FLOWERS AND LEAVES OF THE PELORIC VIOLET

Figure 17

A spray of flowers with aestival (summer) leaves from the peloric strain. Notice the unusual forms of the flowers and the numerous saccate or lip petals. Somewhat reduced.

A PELORIC VIOLET

Further Observations of an Abnormal Form of *V. Primulaefolia*

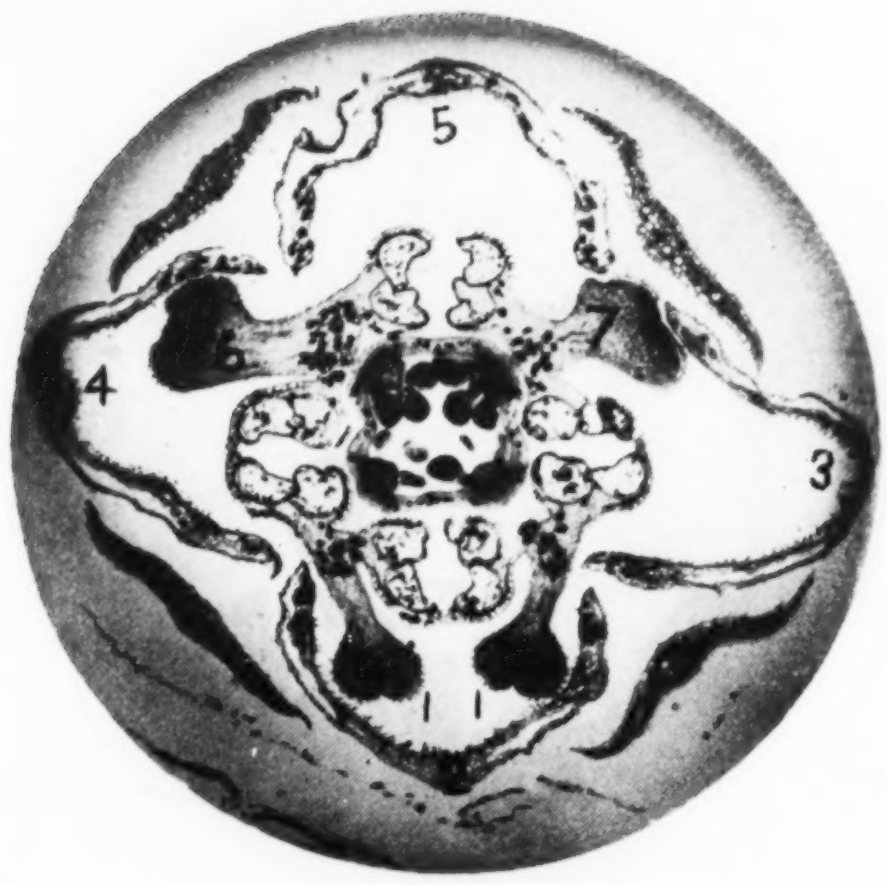
L. R. Detjen
University of Delaware

A VIOLET plant bearing abnormal flowers was observed by the writer in the spring of 1912 near Raleigh, North Carolina, growing among hundreds of other violet plants bearing normal flowers. The flowers were abnormal in two respects. First, in regard to form; and second, in regard to number of component parts constituting the floral whorls.

The abnormality in regard to form of flowers was due to the tendency on the part of the plant to produce regular (peloric) instead of the normal irregular flowers. Some of the flowers were apparently normal, and some apparently perfectly regular, while by far the greater majority of them constituted intermediate stages between the truly normal and the perfectly peloric flower. The intermediate type is quite variable and depends chiefly on the change in number of component parts constituting the floral whorls and also on the interchange of component parts within the whorls themselves. A normal flower of *Viola primulaefolia L.* consists of the following parts: A calyx of five sepals, three of which are exterior, large and visibly auricled, and two included sepals much smaller in size; a corolla of five petals, consisting of two standards, two wings and one lip petal, the last being abundantly pubescent and striate within and saccate, the sac containing the two single stamen appendages; a five-stemmed androecium with five pairs of anthersacs, three of the stamens being without any appendages and two (those adjacent to the saccate petal) bearing each a single stamen appendage; and a three-carpellary pistil with three placentae, the style above the ovary being curved and the pore tube slanting at a sharp angle.

The flowers of the peloric plant were extremely variable in regard to number of component parts in the respective floral whorls. Some few were apparently perfectly normal but many that appeared so superficially showed variations when examined with the microscope. Also few appeared perfectly peloric in form and uniform in the numbers of component parts of the floral whorls, but among these when studied with the microscope many variations were detected. The rest of the flowers was a variable lot indeed; the sepals ranged from four to five in number, the petals from four to seven, the saccate petals from one to five, any one of the wings and standards being subject to replacement by a saccate petal, the stamens from three to six, some of these being monstrous forms with many anthersacs, the anthersacs from eight to sixteen and more, the stamen appendages from two to eight, some of these being double, some triple and some few plainly showing evidence of division to form twin appendages, the carpels in the pistil varied from three to four in number with a corresponding number of placentae. The pore tube and the curved style also showed a great variation in departure from the normal. In the truly 4-merous peloric flowers, the style was perfectly straight and symmetrical and the pore tube centered and vertical in position. The flowers themselves seemed to have lost all sense of equilibrium.* The lip

*For a complete description of this violet see *Torreya*, vol. 20, No. 6, Nov.-Dec., 1920.



Peloric

Normal

CROSS SECTIONS OF VIOLET FLOWERS

Figure 18

The peloric form differs greatly from the normal in the arrangement of the flower parts. The peloric flower shown above illustrates the 4-merous type found associated with the new strain. Notice that all of the standards and wings are replaced by saccate petals. 1, Normal stamen appendages; 2, normal saccate petals; 3, 4, 5, extra saccate petals; 6, 7, extra stamen appendages. Magnified 14 diameters.

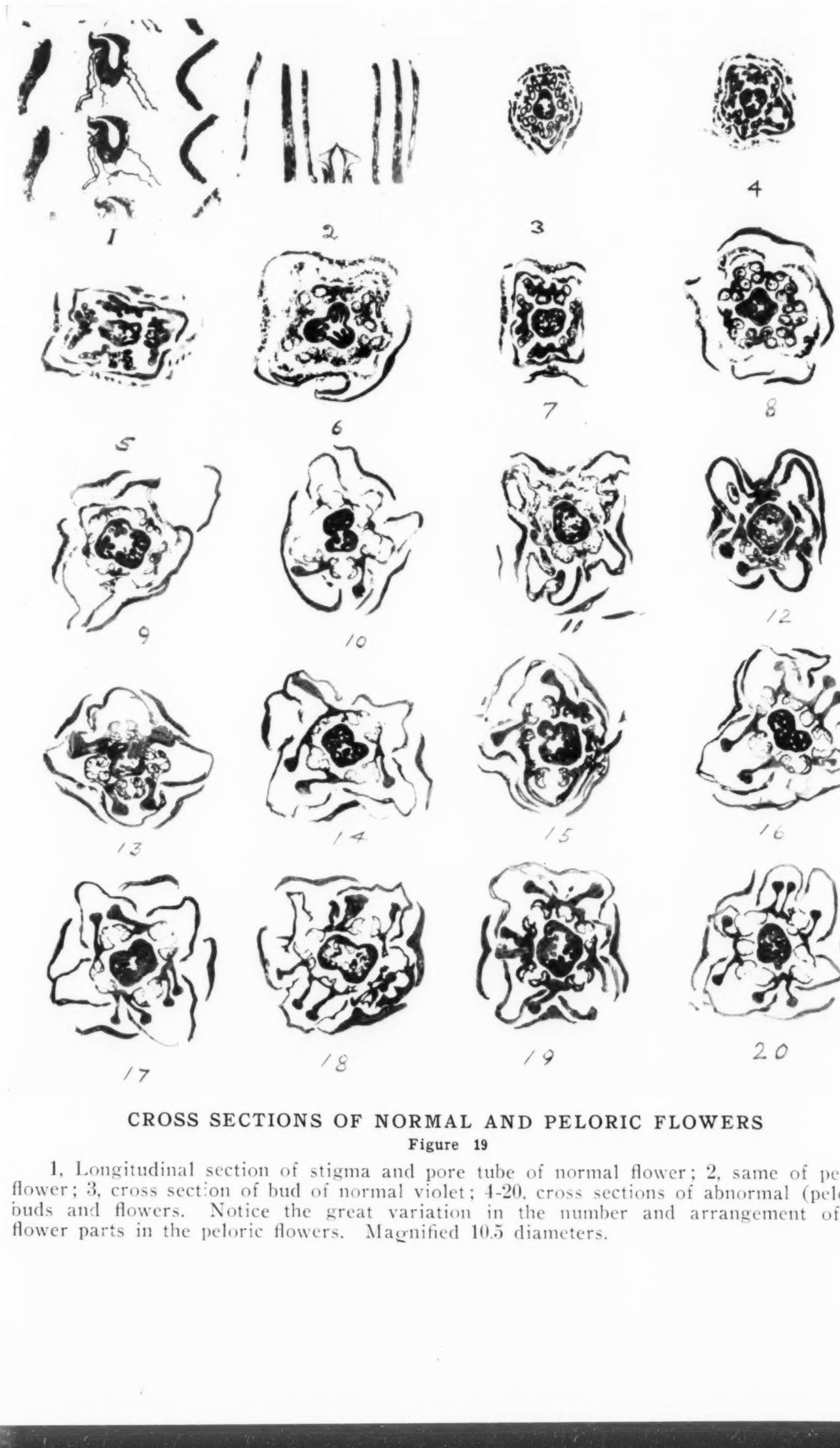
petal might be situated on the lower side but equally as often to one side or the other and even on the top or uppermost part of the flower.

Such were the forms of the flowers of the new plant and great the departure from the normal. What this form of violet flower represents is only problematical. It might represent a reversion to an ancient ancestral form upon its first departure from the even numbered, 4-merous, regular type of flower or it might represent an altogether new form, an evolution never described in any other species of Viola.

In view of the fact that the capsules of *V. primulacfolia* originate from cleistogamous flowers, the writer predicted that this plant might breed reasonably true; and therefore represent a mutation, reversion or evolution created by Nature in the natural environment of the parent species.

In order to test this theory, the plant bearing the abnormal flowers was taken up in full bloom and transplanted to the garden for closer observation. It thrived in its new environment and later the same season bore some seed pods. The seeds were gathered and sowed in a flat. Sixteen new plants were secured and the following spring, these were set in the garden. The plants bloomed the first spring and all of them appeared not unlike the parent plant. These sixteen plants were grown and renewed by runners for the next eight years.

In **1920**, the writer moved from Raleigh, North Carolina, to Newark, Delaware, and in **1921** had some five hundred flowers together with some live plants sent in for further observations and work. These plants were planted out of doors and grown for one year and then moved under glass for better control of the soil and moisture conditions. Under glass the plants continued to thrive and multiply, and in **1923** they bloomed. Some



CROSS SECTIONS OF NORMAL AND PELORIC FLOWERS

Figure 19

1, Longitudinal section of stigma and pore tube of normal flower; 2, same of peloric flower; 3, cross section of bud of normal violet; 4-20, cross sections of abnormal (peloric) buds and flowers. Notice the great variation in the number and arrangement of the flower parts in the peloric flowers. Magnified 10.5 diameters.

seed pods developed and matured viable seeds. Flowers were gathered for study and seeds were collected and immediately reseeded. Some of the seed pods were four-sided and some three. The seeds from the four and three-sided seed pods were sown separately and the new plants carefully watched. They all bloomed in December of the same year. Flowers were again gathered for study.

By means of dissecting fresh flowers and a study of paraffine section of others, it was observed that the flowers of the third generation did not differ from any of the preceding or from the parent plant itself. The prediction that the original plant might breed true seems to have been verified now by breeding work carried through three successive generations and the conclusion, therefore, seems inevitable that this strain of peloric violet is a true mutation, created by Nature in the wild and in the midst of hundreds of normal plants. This strain if successfully re-established in the wild, might become the progenitor of an entirely new race of violets. Efforts are being made to establish plants in the lowlands near Newark, Delaware, and many seeds were scattered in earlier years near Raleigh, North Carolina. Whether the strain will hold its own in nature, time alone will tell.

19,000 Auto Deaths in 1924

Automobiles caused 19,000 deaths and injuries to 450,000 persons in the United States in 1924 statistics made public by the National Bureau of Casualty and Surety Underwriters revealed. This represents a daily average of 52 dead and approximately 1,232 injured.

Notwithstanding the death total, the largest ever reported, the bureau found signs of encouragement in a pronounced fall in the rate of increase of accidents. The increase in the number of deaths in 1923 over figures for 1922 was 20 per cent, while the increased in 1924 over the preceding year was only 4 per cent. This reduction in the rate of increase was attributed to organized campaigns to reduce accidents.

Death Rate and Cars Registered

A comparison of the automobile death rate with the number of cars registered shows a steady decrease, the bureau reported. In 1915 the number of deaths for every 10,000 automobiles was 24, each succeeding year showing a decrease, until the figures for 1924 indicate only 9.6 deaths for every 10,000 cars. There are now 17,500,000 cars registered in the United States.

Grade-crossing accidents took a toll of 1,688 deaths, a decrease of 71 from the 1923 total.

Since 1908 the death rate due to motor-car accidents has increased stedily, until today automobiles cause more deaths than all other vehicles, including trains and street cars, combined.

—*Associated Press,*
New York, May 4, 1925.